With METALLURGICAL SUPPLEMENT.

Engineering Library

The Engineer.

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The Engineer

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PUBLIC NOTICES

Assistant Engineers (2) REQUIRED by the RAILWAY DEPARTMENT of the FEDERATED MALAY STATES GOVERNMENT for four years' service, with possible extension. Salary 400 dollars, rising to 475 dollars a month by annual increments of 25 dollars a month, and thereafter in the event of the officer being retained, rising to 800 dollars a month, plus a temporary non-pensionable allowance of 10 per cent. for bachelors and 20 per cent. for married men. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but the purchasing power of the dollar in Malaya is considerably less than that of 2s. 4d. in the United Kingdom. No income tax is at present imposed by the Federated Malay States Government. Free passages provided. Candidates, age 23 to 30, preferably unmarried, must have received a good theoretical training, preferably at a University or a College recognised by the Institution of Civil Engineers and possess a Civil Engineering Degree or obtained such other diploma or distinction in engineering as the Secretary of State may decide in any particular case, or completed their articles with a civil engineer of good standing and have passed the examination for Associate Membership of the Institution of Civil Engineers. Should have had at least one year's practical experience of Railway Maintenance on a British railway.—Apply at once by letter, giving brief details of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, mentioning this paper and quoting clearly at head of application M/15103. 7306

Assistant Engineers Required for the RAILWAY DEPARTMENT of NIGERIA for a tour of 12 to 18 months' service, with possible extension. Salary £480, rising to £920 a year. Outfit allowance of £60 on first appointment. Free quarters and passage, liberal leave on full salary. Candidates, aged 23 to 35, should either possess an engineering degree of a recognised university or should have passed Sections "A" and "B" of the Associate Membership Examination of the Institution of Civil Engineers. They should also have had 3 or 4 years' regular training as a Civil Engineer, preferably on Railway Works.—Apply at once by letter, stating age, particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/15394. 7307

Assistant Engineers Required for the PUBLIC WORKS DEPARTMENT of the FEDERATED MALAY STATES for four years' service, after which, subject to satisfactory service, the officers appointed will be eligible for confirmation in the permanent and pensionable establishment. It is probable that the number of permanent appointments will be sufficient for those officers whose services have been entirely satisfactory, but no guarantee can be given. If at the end of four years' service an officer's services have been entirely satisfactory and he is not offered or declines further employment, he will be paid a bonus of 2850 dollars. Salary 400 dollars a month, rising to 800 dollars by annual increments of 25 dollars plus a temporary non-pensionable allowance of 10 per cent. for bachelors and 20 per cent. for married men. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is considerably less than that of 2s. 4d. in the United Kingdom. No income tax at present imposed by the Federated Malay States Government. Free passages provided. Candidates, age 23 to 26, preferably unmarried, must have received a good theoretical training, preferably at a University or College recognised by the Institution of Civil Engineers and possess a Civil Engineering Degree or obtain such other diploma or distinction in engineering as the Secretary of State may decide in any particular case, or have completed articles with a Civil Engineer of good standing, and have passed the examination for Associate Membership of the Institution of Civil Engineers. In addition candidates must have had at least one year's practical experience of Civil Engineering under a qualified Civil Engineer.—Apply at once by letter, giving brief details of qualifications and experience and stating age and whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting clearly at the head of application M/15224. 7309

Engineer Cadets Required for the RAILWAY DEPARTMENT of the FEDERATED MALAY STATES GOVERNMENT for two years' service in the first instance. Salary dollars 350 a month for the first year and dollars 375 a month for the second year, plus a temporary and non-pensionable allowance of 10 per cent. In the event of the officer's services being entirely satisfactory they may be offered a further agreement as Assistant Engineer upon the scale dollars 400 a month, rising to dollars 800 a month by annual increments of dollars 25 a month, with prospect of permanent and pensionable employment. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but the purchasing power of the dollar in Malaya is considerably less than that of 2s. 4d. in the United Kingdom. No income tax is at present imposed. Free passages provided. Candidates, aged 22 to 25, unmarried, must have (A) received a good theoretical training at a University or College and have passed the examination qualifying him for Associate Membership of the Institution of Civil Engineers or hold an engineering degree or diploma recognised as granting exemption from Sections "A" and "B" of the A.M.I.C.E. examination, or (B) completed his articles with a Civil Engineer of good standing and have passed the A.M.I.C.E. examination.—Apply at once by letter, giving particulars of age, qualifications and practical experience (if any), to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/15162A. 7308

The Institution of Mechanical Engineers.

THE FIRST
THOMAS LOWE GRAY LECTURE, 1928.

Professor C. J. HAWKES, M.Sc., Member, will deliver the above Lecture on
"THE MARINE OIL ENGINE,"
at the Institution, Storey's-gate, Westminster, on Friday, 6th January, 1928, at 6 p.m.
VISITORS ARE INVITED.
The Lecture will be repeated in Bristol on 11th January, in Cardiff on 12th January, in Glasgow on 2nd February and in Liverpool on 15th February. 7311

Borough of Stockton-on-Tees.
TO BOILERMAKERS.
The Corporation is prepared to receive TENDERS for the SUPPLY and PLACING on its SEATING at their Public Baths, Bath-lane, a NEW LANCASHIRE BOILER, 22ft. long by 7ft. diameter, with all necessary Mountings, &c., suitable for a working pressure of 100 lb. per square inch.
Tenders, with the maker's complete specification, stating earliest date when delivery can be given, endorsed "Tender for Boiler," to be delivered to the undersigned not later than 10 a.m. on Monday, the 9th January, 1928.
The lowest or any Tender will not necessarily be accepted.
THOS. DOWNEY,
Town Clerk.
Borough Hall, Stockton-on-Tees,
23rd December, 1927. 7314

City of Liverpool.
BATHS AND WASHHOUSES DEPT.
The Corporation invite TENDERS for CORNISH BOILER, 15ft. by 6ft., and FITTINGS for Woolton Baths.
Specification may be obtained from the Baths Manager, 75, Dale-street, Liverpool, on payment of Half a Guinea, returnable to senders of bona fide Tenders.
Tenders must be delivered by letter post at the Town Clerk's office (in the envelope provided) not later than Noon on Tuesday, the 17th January, 1928.
The Corporation do not bind themselves to accept the lowest or any Tender.
WALTER MOON,
Town Clerk.
Town Clerk's Office, Liverpool,
23rd December, 1927. 7317

The Madras and Southern MAHRATTA RAILWAY COMPANY, Ltd., 25, Buckingham Palace-road, Westminster, S.W. 1, invite TENDERS for:—
METALS (comprising Aluminium, Antimony, Brass Rods, Sheets and Wire, Copper Ingots, Rods, Sheets, Tubing, Wire, Phosphor Copper, Lead Piping, Sheeting and Zinc Sheets, &c.).
Tenders are due in on Tuesday, 10th January, 1928, by 2 p.m. Tender form obtainable at above address; fee One Guinea, which is not returnable.
The Directors do not bind themselves to accept the lowest or any Tender. 7305

PUBLIC NOTICES

Loughborough Corporation
WATERWORKS.
15-INCH MAIN FROM NANPANTON.
The Corporation of Loughborough invite TENDERS from competent contractors for PROVIDING and LAYING about 1¼ MILES of 15in. SPUN CAST IRON PIPES from Nanpanton to Loughborough.
The plans and specification may be seen at the office of the Consulting Engineers, Messrs. G. and F. W. Hodson, M. Inst. C.E., Bank Chambers, Loughborough, from whom copy of the particulars may be obtained on deposit of cheque for £5 5s., which will be refunded on receipt of bona fide Tender and the return of the documents.
Tenders to be sent to the undersigned not later than Monday, the 16th January, 1928.
The Corporation do not bind themselves to accept the lowest or any Tender.
Dated 23rd December, 1927.
HARRY PERKINS,
Town Clerk.
Town Hall, Loughborough. 7310

South Indian Railway Company, LIMITED.
The Directors are prepared to receive TENDERS for the SUPPLY of:—
STEEL WORK FOR BRIDGES.
Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.
Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Steel Work for Bridges," must be left with the undersigned not later than Twelve Noon on Friday, the 20th January, 1928.
The Directors do not bind themselves to accept the lowest or any Tender.
A charge, which will not be returned, will be made of £1 for each copy of the specification.
Copies of the drawings may be obtained from the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.
A. MUIRHEAD,
Managing Director.
91, Petty France, Westminster, S.W. 1,
23rd December, 1927. 7319

PUBLIC NOTICES

The Assam-Bengal Railway COMPANY, Limited, is prepared to receive TENDERS for:—
20 SPARE BOGIE TRUCKS (with Wheels and Axles).
Specifications and Tender forms may be obtained at the offices of the Company, Bishopsgate House, 80, Bishopsgate, E.C. 2.
A fee of £1 1s. is charged for each specification, which cannot under any circumstances be returned.
Drawings may be had, at the cost of the tenderer, by application to Messrs. Hodges Bennett and Co., Ltd., 78, Queen Victoria-street, E.C. 4.
Tenders must be delivered at the Company's offices not later than Noon on Thursday, 12th January, 1928.
The Directors do not bind themselves to accept the lowest or any Tender.
By Order of the Board,
THOS. C. BRETT,
Secretary.
21st December, 1927. 7298

Urban District Council of NEWRY
NOTICE TO BRIDGE BUILDERS.
TENDERS FOR NEW STEEL SWING BRIDGE.
The Urban District Council of Newry invite TENDERS for the CONSTRUCTION of a NEW SINGLE-LEAF STEEL SWING BRIDGE over the Canal at Godfrey Bridge, Newry. Full particulars regarding design, alterations and additions to abutments and plan of site can be obtained from Mr. C. Blaney, Town Surveyor, Town Hall, Newry, on payment of the sum of £1 1s., which will be refunded to contractors who submit a bona fide Tender.
The price and all other things being equal, a preference shall be given to contractors employing exclusively trades union labour under trades union conditions and also to those undertaking to employ local fitters in the erection of the bridge at the site.
Contractors will be required to provide at their own expense a bond from an approved Insurance Company or Guarantee Society, for the due fulfilment of the contract, and a letter must accompany the Tender from the Insurance Society or Company proposed undertaking to supply the required bond.
Contractors are required to state when tendering the shortest time they will require for the completion of the work.
Designs and specifications should be delivered to the Town Surveyor on or before Thursday, 23rd February next, and sealed Tenders, addressed to the Chairman, Urban District Council, Town Hall, Newry, and endorsed "Tender for Steel Swing Bridge," will be received up to Noon on Monday, 27th February, 1928.
The Council shall have the right to accept any Tender provisionally subject to the approval of the Ministry of Home Affairs, N.I.
The Council shall not be bound to accept the lowest or any Tender.
Dated this 23rd day of December, 1927.
By Order,
W. M. CRONIN,
Town Clerk.
Council Offices,
Town Hall, Newry. 7318

Middlesbrough Board of GUARDIANS.
HOLGATE INSTITUTION.
The Guardians of the Middlesbrough Union REQUIRE a CHIEF ENGINEER to Take Entire Control of the Heating and Hot Water Plant recently installed at their Holgate Institution and Hospital, situate at Linthorpe, Middlesbrough. The accommodation of the Institution (patients and staff) is approximately 1000. Candidates for the appointment must have had control of a heating and hot water plant in an up-to-date Institution, and persons without this experience need not apply. The person appointed will be required to keep log books and charts to record the temperature and steam pressure in the various departments, also the coal, water, gas, and electricity consumption. He will be required to reside at such distance from the Institution as may be approved by the Guardians. The salary will be after the rate of £300 per annum. Applications, in the candidates' own handwriting, stating age, whether married or single, present and previous employment, and accompanied by copies of three testimonials of recent date, together with the names and address of two persons or firms to whom the Guardians may refer as to the candidates' practical engineering experience, must reach me, the undersigned, not later than 10 a.m. on Wednesday, the 11th January, 1928.
H. BILSON,
Clerk to the Guardians.
Poor Law Offices,
Municipal Buildings, Middlesbrough,
23rd December, 1927. 7316

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

P3852. November 4th.—ADVERTISER for Technical Assistant, &c., desires to THANK all APPLICANTS, and now has to state that the POSITION has been FILLED. 7299 A

WANTED, ESTIMATOR, with Sound Experience in Engineering, Constructional and General Factory Building Work. Must have thorough knowledge of present-day costs and labour rates.—Address, 7281, The Engineer Office. 7281 A

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SITUATIONS OPEN (continued)

WANTED, ENGINEER MANAGER for Cement Works in India. First-class return passage, Bungalow, light and fuel provided.—Applicants should state age, experience, salary required, also attach testimonials and references, to Z.O. 737, care Deacon's Advertising Offices, Fenchurch-avenue, London, E.C. 3. 7304 A

WANTED for General Engineering Works, First-class RATE FIXER. Salary £4 10s. per week. Only men with experience need apply.—Address, 7315, The Engineer Office. 7315 A

WANTED, Young Capable MAN with Knowledge of Agricultural Implements, to Assist in Developing Manufacturing Business in South of England. The post would lead to a responsible position to a suitable man.—Write fullest particulars to "C. F.," c/o J. W. Vickers and Co., Ltd., 24, Austin Friars, London, E.C. 2. 7296 A

APPLICATIONS (IN STRICT CONFIDENCE) INVITED FOR THE POSITION OF ENGINEER TO A LARGE MANUFACTURING ORGANISATION NOW DEVELOPING IN THE LONDON AREA.
APPLICANTS SHOULD NOT BE LESS THAN 35 YEARS OF AGE AND MUST BE FULLY QUALIFIED IN MECHANICAL AND ELECTRICAL BRANCHES, CAPABLE OF SUPERVISING FROM FOUNDATION TO FINISHED FACTORY, AND AFTERWARDS TAKE OVER RUNNING AND MAINTENANCE AND EXTENSIONS.
GOOD SALARY WILL BE PAID TO SUITABLE MAN AND NONE WHO HAVE PREVIOUSLY BEEN IN RECEIPT OF LESS THAN £750 PER ANNUM NEED APPLY.
SEND FULL PARTICULARS, TRAINING AND EXPERIENCE, ALONG WITH COPIES OF REFERENCES AND TESTIMONIALS, AND MENTION SALARY EXPECTED.
Address, 7326, The Engineer Office. 7326 A

ASSISTANT to GENERAL MANAGER of Engineering Works (1000 hands). Must have all-round capacity, especially on commercial side, with initiative and drive. Not over 30. State fully, in confidence, business experience, age, where educated and salary required.—Write, "RIGHT," c/o Street's, 6, Gracechurch-street, E.C. 3. 7325 A

ENGINEER SALESMAN REQUIRED, Resident London, for Centrifugal Oil Purifiers, &c.; must be expert salesman and organiser and technical knowledge essential. Salary and commission, with prospects.—Address, P3990, The Engineer Office. P3990 A

HANS RENOLD, Ltd., REQUIRE the SERVICES of ENGINEER-SALESMEN for the South Wales and Glasgow districts. Must have had first-class experience of Conveyor and Elevating Machinery. Previous experience as salesman essential.—Write, giving full details as to experience, education, age and salary required, to EMPLOYMENT DEPARTMENT, Burnage Works, Didsbury, Manchester. 7295 A

REPRESENTATIVES WANTED for GREAT BRITAIN and IRELAND calling on Steam Users, also REPRESENTATIVES calling on Valve Manufacturers and Brassfounders, for Sale of High-quality Article at competitive prices. On generous commission only. Men calling frequently in small concentrated areas preferred. Light samples.—Address, giving age, experience, territory covered, and full particulars in confidence, 7269, The Engineer Office. 7269 A

WANTED, Good MECHANICAL DRAUGHTSMAN, used to General Engineering, London area.—Address, stating age, experience, and salary required, 7321, The Engineer Office. 7321 A

WANTED, TWO DRAUGHTSMEN. Preference given to applicants with experience in Centrifugal Pump or Condenser Design. State age, experience, salary required, &c.—Address, 7313, The Engineer Office. 7313 A

DRAUGHTSMAN WANTED, Experienced in Elevating and Conveying Machinery, for London district.—Address, stating age, experience in detail, and salary required, 7322, The Engineer Office. 7322 A

DRAUGHTSMAN WANTED for Machine Details, gearing, &c.—Address, 7327, The Engineer Office. 7327 A

DRAUGHTSMAN (Young) REQUIRED, with Refrigeration experience. State salary and qualifications.—Address, 7301, The Engineer Office. 7301 A

FIRST-CLASS MECHANICAL DRAUGHTSMAN for Works Reconstruction in Kent. Expert knowledge of Elevating and Conveying Machinery essential. Cement Plant experience an advantage. State age and salary.—Address, 7312, The Engineer Office. 7312 A

HEATING and VENTILATING DRAUGHTSMEN of good education and well versed in Mathematics and the calculations involved in designing schemes.—Address, 7320, The Engineer Office. 7320 A

MECHANICAL DRAUGHTSMAN REQUIRED for a Large Industrial Concern. Applicants must be well educated and have had sound training in workshop and drawing-office. One accustomed to Machine Design and Plant Lay-out preferred. Age not over 30.—Address, stating experience, training, references, and salary required, P4009, The Engineer Office. P4009 A

PRODUCTION DRAUGHTSMEN.—TWO REQUIRED IMMEDIATELY for Aircraft. In addition to experience as draughtsmen applicants must have been employed in fitting and machine shops on small parts.—Apply to Box 716, Shaw and Blake, Ltd., 8, Bell-yard, Temple Bar, London, W.C. 2, Advertising Agents. 7293 A

TEMPORARY CONSTRUCTIONAL STEEL WORK DRAUGHTSMAN REQUIRED, London district.—Address, 7297, The Engineer Office. 7297 A

A LONDON RAILWAY COMPANY Invites APPLICATIONS to fill a vacancy for a SMITH SHOP FOREMAN for a Repair Works in London; 30 men in shop. Commencing salary £275 per annum, permanent appointment to a suitable man.—State age and full details of experience to Box B. J. T., c/o Davies and Co., 95, Bishopsgate, London, E.C. 2. 7279 A

REQUIRED for Large Engineering Establishment, FOREMAN BOILERMAKER; must be thoroughly up to date in all classes of Boiler Work, including Water-tube Boilers.—Address, stating age, salary required, and full particulars of experience, with recent references, 7303, The Engineer Office. 7303 A

WORKING CHARGE HAND WANTED for Works in the North of England. Good opening for man with first-class experience in the manufacture of Switch and Control Gear, also Switchboards. Only men of ability, able to control men and boys, need apply, enclosing copies of references and stating wages required.—Address, 7323, The Engineer Office. 7323 A

SITUATIONS WANTED

ENGINEER SALESMAN, M.I. Mech. E., WISHES to HEAR from FIRST-CLASS FIRM REQUIRING REPRESENTATION in London and the home counties in a position where his technical and sales experience would have good scope. Commission and reasonable expenses preferred.—Address, P4010, The Engineer Office. P4010 B

EXPERIENCED ENGINEER SALESMAN (28) WISHES to HEAR from MANUFACTURERS desirous of EXTENDING their BUSINESS in London area. Salary, expenses and commission or commission only.—Address, P4007, The Engineer Office. P4007 B

DRAUGHTSMAN, at Present Finishing His Time in Baghdad, would LIKE a POSITION in England, about April or May. Broad experience, age 32.—Address, P3969, The Engineer Office. P3969 B

PARTNERSHIPS

IF YOU ARE SEEKING
A PARTNER or PARTNERSHIP
or wish to buy or sell a
BUSINESS or WORKS
Write:
WHEATLEY KIRK, PRICE & CO.,
46, Watling Street,
London, E.C. 4.
Established over 75 years.

If you wish to purchase or sell a Business connected with the Engineering or allied Industries consult:
HENRY BUTCHER, HALL & CO.,
63 & 64, CHANCERY LANE,
LONDON, W.C. 2.

PARTNER REQUIRED by Consulting Naval Architect, established pre-war. Capital necessary.—Address, 7286, The Engineer Office. 7286 C

EDUCATIONAL

Correspondence Courses
OF PREPARATION FOR THE
Examinations of the
INST. OF CIVIL ENGINEERS,
INST. OF MECHANICAL ENGRS.,
INST. OF STRUCTURAL ENGRS.,
UNIVERSITY OF LONDON, &c.
are personally conducted by
Mr. Trevor W. Phillips,
B.Sc., Honours, Engineering, London University, Assoc. M. Inst. C.E., A.M.I. Struct. E., M.R.S.I., F.R.S.A., Chartered Civil Engineer, &c.
For full particulars and advice, apply to:—8-11, TRAFFORD CHAMBERS, 58, SOUTH JOHN ST., LIVERPOOL (Tel. Bank 1118). LONDON OFFICE:—65, CHANCERY LANE, W.C. 2. Ex.

ENGINEERS.—Here is Your Opportunity! The A.M.I. Mech. E., A.M.I.A.E., A.M.I.E.E. qualification is a certain passport to a responsible post. Our FREE 64-pp. book, "ENGINEERS' GUIDE TO SUCCESS," will show you how to obtain any Engineering Qualification easily. Forty Engineering Diploma Courses also described.
Write now, stating branch or exam. which interests you, to—
TECHNOLOGICAL INSTITUTE,
P3992 B 76, Thanet House, 231, Strand.

LEARN DRAUGHTSMANSHIP.—Well-paid EMPLOYMENT is always OPEN to trained Draughtsmen and Tracers. Men who are working in uncongenial or badly paid jobs, or who have failed in a technical examination, should send for details of my simplified Postal Courses in Draughtsmanship and Tracing. Many fully qualified Civil and Mechanical Engineers owe their success to my special Courses, which include Civil, Mechanical, Structural, Electrical, and Motor Engineering. Also Machine Drawing and Design, Jig and Tool Design, Hydro-electric Plant Design, and Building Drawing. Write to me for free advice.—PERCY PITMAN, M.I. Mech. E., 25, Victoria-street London, S.W. 1. (Established 1894). Phone: Victoria 2186. Ex

TO ENGINEERS GOING ABROAD AND OTHERS.—Thorough PRACTICAL INSTRUCTION GIVEN in SURVEYING and LEVELLING.—Address, E. MOUL, Hollybank, Woking. P3961 E

MISCELLANEOUS

MANUFACTURERS and AGENTS Wishing to Increase sales, should write for particulars of HIRE-PURCHASE SCHEMES to J. N. JONES and CO., 15, Red Lion-street, High Holborn, London, W.C.1 P3978 I

PRESS NOTICES, Forewords, Pamphlets, &c., prepared in clear, attractive wording by Engineer with many years' editorial experience.—W. O. HORSNAILL, A.M.I. Mech. E., A.M.I.E.E., 20, High Holborn, London. Phone, Chancery 7217. 6829 I

AGENCIES

AGENT WANTED, Calling on Engineers, Motor Works, &c., in Lancashire, Birmingham, and London. First-class side lines. Car essential, commission basis, exceptional opportunity, good prospects.—Address, P4008, The Engineer Office. P4008 D

FIRM of ENGINEERS, Newcastle, Good Connection with engineering firms and superintendent engineers in that district, are OPEN to ACT as REPRESENTATIVES to First-class British or Continental Firms.—Address, 4000, The Engineer Office. 4000 D

PATENTS

BRITISH PATENT No. 270,155. "Tool for Planting Bulbs and Other Roots, for Extracting Weeds, &c.," awarded Bronze Medal, International Exhibition of Inventions, London, 1927. Owner wishes to DISPOSE of PATENT RIGHTS by SALE, LICENCE or other arrangement.—A. WILLIAMS PRICE, Works and Costs Accountant, Cefn Bychan, Ruabon, North Wales. P3989 H

"IMPROVEMENTS IN PARTIALLY IMMERSED SHIPS' PROPELLERS," British Patent No. 228,177.—The OWNERS of the above PATENT are DESIROUS of MAKING ARRANGEMENTS whereby the same may be adequately WORKED in Great Britain under LICENCE.—Particulars obtainable from TECHNICAL RECORDS, Ltd., 59-60, Lincoln's Inn-fields, London, W.C. 2. 7300 H

KINGS PATENT AGENCY, Ltd. (B. T. KING, Regd. Patent Agent, G.B., U.S., and Can.). Advice handbook and cons. on Patents and Trade Marks FREE.—146a, Queen Victoria-street, London, E.C. 4. 40 years' refs. 'Phone: Central 0682. 6825 H

FOR HIRE

APPLY TO RICHD. B. BATCHELOR, ARTESIAN WELL & CONSULTING ENGINEER (WATER SUPPLIES EXPERT).
All equipments for improving your Water Supply. Largest Well Boring Plant, 3in. to 9ft. diam. Every description of Pumping Plant.
73, Queen Victoria-st., E.C. 4; & Chatham.
'Phones: Central 4068; Chatham 71.
Wires: Boreholes, London; Watershed, Chatham.
ESTAB. OVER 150 YEARS.

FOR SALE or HIRE, ELECTRIC MOTORS, from 60 to 300 H.P.; PORTABLE STEAM ENGINES, from 8 to 40 N.H.P.; STEAM BOILERS, CRANES, PUMPS, MACHINE TOOLS of every description; reasonable terms, immediate delivery.—J. T. WILLIAMS and SONS, 37, Queen Victoria-street, London, E.C. Tel., City 3038. Ex

FOR HIRE, PUMPS and WELL-BORING TOOLS for Trial Borings and Deep Wells.—R. RICHARDS and CO., Upper Ground-street, London, S.E. Telephone No. 0978 Hop. 822 K

AUCTIONS

Fuller, Horsey & Co.'s Advertisements
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IMPORTANT EIGHT DAYS' SALE of the ENTIRE CONTENTS of the GLOBE IRONWORKS of JOHN MUSGRAVE and SONS, Ltd., BOLTON, LANCS.—Messrs.

Fuller, Horsey, Sons and Cassell
will SELL by AUCTION, in Lots, on the PREMISES, on TUESDAY, JANUARY 31st, 1928, and FOLLOWING DAYS, at Eleven o'clock precisely each day,
HIGH-CLASS MACHINE TOOLS,
including 70 Screw-cutting and other Lathes, 10 Combination and other Turret and Capstan Lathes, by Herbert, Brown and Sharpe, &c., Potter and Johnston and Cleveland Automatics, 24 Horizontal and Vertical Milling Machines, by Brown and Sharpe, Le Blond, Kendall and Gent, Becker and others; 4 Plano Type Ditto; 9 Planing Machines, up to 30ft. by 10ft. by 10ft.; 4 Side Planers, up to 12ft. by 9ft. 6in.; 7 Universal, Plain and Surface Grinders, by Brown and Sharpe, Norton, Churchill, &c.; Disc and Tool and Cutter Grinders, various; 10 Pearn-Richards No. 4 and other Horizontal Boring Machines; 9 Duplex and other Vertical Boring and Turning Mills, by Bullard, Richards, &c.; 25 Radial, Pillar and Sensitive Drilling Machines; Noble and Lund 48in. Band Saw; Haigh 7ft. Broaching Machine; Richards' Keyseater; Power Hack Saws.
FOUNDRY PLANT,
including Six Cupolas, Two Bonvillain Hydraulic Moulding Machines, 8ft. Loam Mill, Four Loam Mixers, Wright Tilting Furnace, Foundry Boxes, Ladles, &c.
SHEET METAL PLANT,
including 6ft. and 3ft. Power Guillotines, Two Power Stamping Presses, Rhodes' 48in. Circle Cutter, 6ft. Folder, Rhodes' Nibbler, Tinmen's Rolls, Swaging Machines, Acetylene Plant, &c.
WOOD-WORKING MACHINERY,
including Two Robinson 24in. Circular Saw Benches, Two 30in. Band Saws, Two Robinson 24in. by 6in. Planing and Thicknessing Machines, 24in. and 12in. Overhead Planers, Oliver 36in. Double Disc Sander, Saw Filing, Plane Iron and other Grinding Machines, Universal Trimmers, &c.
MOTIVE POWER,
including Forty 460-volt D.C. Motors, 5 H.P. to 140 H.P.; Forty-three 400/440-volt A.C. Motors, 3-phase, 50 periods, 7½ H.P. to 200 H.P.; Crompton 6½ kVA, 440-volt, 3-phase Alternator, 12 kW, 110-volt Motor Generating Set, Lancashire Boiler, by Musgrave, 8ft. by 30ft. (170 lb. w.p.), with Superheater, Green's 120-tube Economiser, Bennis Coal Elevator.
MISCELLANEOUS PLANT
A 20-Ton Wagon Weighbridge, 12 Avery Weighing Machines (5 cwt. to 3 tons), Musgrave 2-stage Air Compressor, Broom and Wade 2-cylinder Compressor, Air Receivers, Massey 1-cwt. Pneumatic Hammer, 100-Ton Hydraulic Mandrel Press, Dorman Die Casting Machine, Two Monometer Metal Furnaces, Avery 30-Ton Universal Testing Machine, Izod Impact Tester, Newall 4ft. Measuring Machine, Air Pump and Pipe Testing Plant, Bar Stretching, Bending and Straightening Presses, Laboratory Apparatus, Gas Furnaces, Heating Plant, Tanks up to 37ft. by 32ft. by 3ft., Pumps, Fans and Blowers, Cylinder Boring Engines and Bars, Marking-off Tables, Hydraulic Jacks, Engineers' Small Tools, Shafting, Belting, Winches, Baulk Timber, &c.
STORES AND MATERIALS
including New Plummer Blocks and Shafting, Fittings, Tool and Mild Steel, Metal Bars, various; Nuts, Bolts, Tinned and Black Steel Sheets, Pig Iron, Electrical Fittings, and large quantity
NON-FERROUS METAL AND WROUGHT AND CAST SCRAP.
Office Furniture, including Typewriters, Time Recorders, Five Dictaphones, Safes, Drawing-office Equipment, Two Kodak Photostats, and numerous other effects.
May be viewed on production of catalogue, to be obtained (when ready) of Messrs. FULLER, HORSEY, SONS and CASSELL, Mechanical Auctioneers and Valuers, 11, Billiter-square, E.C. 3. 7289 J

TO USERS OF STEAM POWER.—Messrs.
Fuller, Horsey, Sons and Cassell
will include in the above SALE a New 450 H.P. Compound Tandem
HEAT EXTRACTION ENGINE,
by Musgrave; cylinders 18½in. and 22in. by 22in. (working pressure 170 lb.), with jet condensing plant. Catalogues may be had as in preceding advertisement. 7290 J

Re the LACRE MOTOR COMPANY, Ltd., of Letchworth, Herts.
By Order of ANDREW BINNIE, Esq., F.C.A., the Receiver for the Debenture Holders.—Messrs.
Fuller, Horsey, Sons and Cassell
are instructed to invite TENDERS for the PURCHASE in ONE LOT of the
GOODWILL OF THE BUSINESS
of this Company, the Makers of the well-known Lacre Van. There will be included in the purchase the whole of the
STOCK OF SPARE PARTS,
WORK IN PROGRESS,
PATTERNS AND DRAWINGS.
Tenders, which must be in the form attached to the particulars, should be delivered to ANDREW BINNIE, Esq., F.C.A., 58, Coleman-street, E.C., by Four o'clock on Thursday, January 12th, 1928.
IMPORTANT NOTICE.
THE LEASEHOLD WORKS
at LETCHWORTH, HERTS., are FOR SALE, and offers for same, with ALL or ANY of the PLANT and MACHINERY, may be made conditional on a Tender for the Goodwill being accepted.
Particulars, with forms of Tender, may be had of Messrs. JACKSON, PIXLEY and CO., Chartered Accountants, 58, Coleman-street, E.C.; or Messrs. WORDSWORTH, MARR, JOHNSON and SHAW, Solicitors, 39, Lombard-street, E.C.; or of Messrs. FULLER, HORSEY, SONS and CASSELL, Auctioneers, Surveyors, and Valuers, 11, Billiter-square, E.C. 3. 7291 J

Re LACRE MOTOR COMPANY, Ltd.—By Order of ANDREW BINNIE, Esq., F.C.A., the Receiver for the Debenture Holders.—Messrs.
Fuller, Horsey, Sons and Cassell
will SELL by AUCTION, in Lots, at this COMPANY'S ENGINEERING WORKS, LETCHWORTH, HERTS., on THURSDAY, JANUARY 26th, 1928, and FOLLOWING DAY, at Eleven o'clock precisely,
ENGINEERS' MACHINE TOOLS,
including Twenty-six Screw-cutting and other Lathes, by the best English and American makers; Thirteen Turret and Capstan Lathes, Gridley 2½in. Single-spindle Automatic, Fifteen Universal and Plain Milling Machines, by Brown and Sharpe, Kempsmith, Herbert, &c.; Universal, Plain and Disc Grinding Machines, by Norton, Churchill, Jones and Shipman, &c.; 18 Radial and Pillar Drilling Machines, 2½in. Broaching Machine, Richards 26in. Duplex Boring Mill, Bullard 32in. Boring Mill, Lucas Horizontal Drilling and Boring Machine, Two Brown and Sharpe No. 4 Gear-cutting Machines, Planing Machine, Slotting and Shaping Machines, Hack Saw Machines, Hydraulic Tyre Press, Nasmiths' Plant, including
CONTINUED IN NEXT COLUMN.

AUCTIONS

Fuller, Horsey & Co.'s Advertisements
Continued from previous column.

Swaging, Burring and Folding Machines; Six Electric Motors, 20 and 10 H.P.; Shafting, Benches, Vices, and other effects.
May be viewed on production of catalogue, to be had of Messrs. JACKSON, PIXLEY and CO., Chartered Accountants, 58 Coleman-street, E.C. 2; or of Messrs. WORDSWORTH, MARR, JOHNSON and SHAW, Solicitors, 39, Lombard-street, E.C. 3; or of Messrs. FULLER, HORSEY, SONS and CASSELL, Mechanical Auctioneers and Valuers, 11, Billiter-square, E.C. 3. 7292 J

TYDFIL ENGINEERING AND SHIP-REPAIRING COMPANY, Limited (in Voluntary Liquidation).
SALE of PLANT, MACHINERY, &c., at WORKS, ROATH BASIN, BUTE DOCKS, CARDIFF.
Sir Illtyd Thomas, F.A.I.,
has received instructions to SELL by AUCTION, on WEDNESDAY, THURSDAY, and FRIDAY, the 4th, 5th, and 6th JANUARY, 1928, the whole of the Valuable
ENGINEERING and SHIP-REPAIRING PLANT MACHINERY, STORES &c.,
including:—
MOTOR-DRIVEN MASSIVE DOUBLE-ENDED PUNCHING, SHEARING and ANGLE CROPPING MACHINE, by Craig and Donald; VERY MASSIVE SET of PLATE BENDING ROLLS, 25ft. 9in. long, by Craig and Donald; Small Set of Ditto; Heavy Radial Drilling Machine; Nearly New LANDIS 3in. HIGH-SPEED SCREWING MACHINE; Very Heavy 24in. centre SELF-ACTING and SCREW-CUTTING BREAK-BED LATHE, by POLLOCK and McNAB, Ltd.; ONE 18in., TWO 12in., TWO 8½in., and ONE 8in. S.S. and S.C. GAP BED and BREAK LATHES; PLATE EDGE PLANING MACHINE, by POLLOCK and McNAB, Ltd., up to 25ft.; 18in. Double Wheel Floor Grinder; Three Radial Drilling Machines; Back-geared Horizontal Boring Machine; 12in. stroke Slotting Machine; Automatic Keyway Cutting Machine; 16/18in. stroke Traversing Head Shaping Machine; Hack Sawing Machine and Planing Machines; COCHRAN MULTITUBULAR BOILER (1917), No. 7489, and Blake Ditto; Several 15 H.P. MOTORS, by Campbell and Isherwood, 400 volts, 3-phase, 50 cycles; also Starters; Overhead Travelling Gantry with 6-Ton Tangye Blocks; Three Swing Gantries with 2-Ton Blocks; Large Quantity of YALE and TANGYE BLOCKS; Crane (45ft. pole), hand power, with two Derricks and Overhead Gears; Austin 30-Cwt. Motor Lorry; Contents of Smiths', Coppersmiths' and Carpenters' Shops, Rigging Loft and Stores, Ships' Winches, Ladders; Quantity of Chains, Timber, Firewood, W.I. and C.I. Scrap.
Also OFFICE FURNITURE, including Roll-top, Slope-top and Knechole Desks, Drawing and other Tables, Safes, Office Stools, Arm and other Chairs, Typewriters, Cupboards, &c. &c.
Sale to commence at Twelve Noon on first day and 10.30 a.m. on other days.
Send postcard for catalogues to the Auctioneer, Sir ILLTYD THOMAS, F.S.I., F.A.I., 17, Quay-street, Cardiff. Tel. 490. 7237 J

FOR SALE

STEEL RAILS.
All Sections.
(British Steel and Manufacture).
POINTS & CROSSINGS,
CHAIRS, etc.
EDWARD SISTERSON, LTD.
St. Nicholas Chambers,
NEWCASTLE-ON-TYNE.

BOILERS, &c., DELIVERED FROM STOCK, subject to being unsold:—
New 30ft. by 7ft. 6in. LANCS., 180 lb. W.P.
New 11ft. by 9ft. CYL. TANKS or RECEIVERS, 80 lb. W.P.
New 10ft. by 4ft. 6in. AIR RECEIVER, 100 lb. W.P.
H. and T. DANKS (NETHERTON), Ltd., Netherton, Dudley. 6628 G

FOR SALE, QUANTITY of DRY HORNBEAM PLANK, 2½in., 3in., and 4in. thick.—Apply, C. R. CLARIDGE, The Basin, Exeter. 7277 G

FOR SALE, SET of TRIPLE-EXPANSION MARINE ENGINES, 650 I.H.P., at 200 lb.—Particulars from 21, Dover-street, Hull. 7285 G

FOR SALE, SISSONS LOCO TYPE BOILER and VERTICAL COMPOUND PISTON VALVE ENGINE, 300 B.H.P., perfect condition and insured. Price £200.
Apply, BORWICK and SONS, Boat Builders, Windermere. 7283 G

FOR SALE, THEODOLITES, DRAWING INSTRUMENTS, SECOND-HAND. CLARKSON'S, 338, High Holborn, W.C. (Opposite Gray's Inn-road).

FOR SALE, LEVELS, DRAWING INSTRUMENTS, SECOND-HAND. CLARKSON'S, 338, High Holborn, W.C. (Opposite Gray's Inn-road). Ex.

FOR SALE, 100 H.P. Maclaren TRIPLE-EXPANSION ENGINE, self-contained, surface condenser, 24in. stroke, speed 125 r.p.m., forced feed lubrication, working pressure 80/150 lb. per square inch, with 10ft. diameter twenty-rope grooved flywheel. Make ideal pumping engine for large pumping station. Photographs on application.—WALES, Ltd., Oozells-street, Birmingham. 7232 G

MACHINERY, PLANT, &c.

5FT. ASQUITH DRILLING MACHINE, Central thrust, low base, S.P.D.
LANDIS 14in. SCREWING MACHINE.
No. 6a "POTTER and JOHNSTON" AUTOMATIC CHUCKING and TURNING MACHINES.
TWO No. 7a SUNDER GEAR PLANERS.
(1) 4-Wheel 8in. SADDLE-TANK STEAM LOCOMOTIVE (Hudswell, Clarke, 1916 make), 3ft. gauge, copper fire-box, 160 lb. W.P.
(2) 4-Wheel 9in. SADDLE-TANK STEAM LOCOMOTIVE (Hudswell, Clarke), 2ft. gauge, copper fire-box, 160 lb. W.P.
ONE Single-ended Two-furnace MARINE BOILER, 11ft. 6in. by 9ft. 1in., re-insure 160 lb. pressure.
TWO First-class Land Type W.I.F. WATER-TUBE BOILERS, by Babcock and Wilcox, Ltd., in 1916, with a heating surface of 4780 square feet and approximate evaporation 19,000 lb. of water per hour, re-insurable at a working pressure of 200 lb. per square inch, with Superheater, Chain-grate Stokers and Steam Fittings.
Nearly New 5-Ton TRACTION ENGINE, by Garrett's, with Wagons and Spares.
CATALOGUE (10,000 LOTS) ON APPLICATION.
THOS. W. WARD LTD.,
ALBION WORKS, SHEFFIELD. Ex

200 TONS NEW WIRE ROPES, Half Price.—THE LONDON ELECTRIC FIRM, Croydon. 6620 G

For continuation of For Sale Advertisements see page 3.

A Seven-Day Journal

A New Musical Instrument.

A PRIVATE demonstration was recently given in London of a new musical instrument invented by Professor Leo Theremin, of the State Institute of Technical Physics, Leningrad. The apparatus consisted of a loud speaker connected with a thermionic valve circuit, which included a metal rod, the electrostatic capacity of which was altered by the proximity of the performer's hand. The principle of the apparatus is based upon an application of the familiar howling of a badly adjusted broadcast receiving set, the intensity of the sounds being controlled by varying the position of the hand in relation to the circuit, or the pressure of the foot upon a disc of carbon. On notes near the middle of the musical scale, the hand was placed a few inches from the rod, and a change in the distance of an inch or so altered the pitch of the note by a tone, the whole range apparently being about an octave. Faulty intonation occurred if the performer failed to place his hand in the correct position with respect to the rod, so as to produce the desired frequency of oscillation. The apparatus is an ingenious application of well-known electrical effects, and it would seem to possess possibilities of development.

High-tension Transmission Accident in Belgium.

THE fall of a high-tension transmission line across a low-tension overhead distribution circuit caused something like a panic in the little town of Lobbes, near Charleroi, during the night of December 18th. According to the accounts of witnesses, flames were seen along the low-tension lines, and almost simultaneously fires broke out in several houses. The night watchmen fired revolvers to give the alarm, and soon the church bells sounded the "tocsin," a custom which is still observed on the Continent in times of great emergency. The whole population turned out and soon the fires, which by then had started in most of the houses, were extinguished. Electric lamps are said to have burst everywhere with loud reports, and shocks were received by anyone attempting to touch the switches, while the electricity meters "vrombissaient" like aeroplane motors. Before things were restored to their normal state two houses were burnt to the ground, and the electricity installations in one quarter of the town were so damaged that a complete replacement will be necessary. In view of the fact that it is customary in Belgium to make the safety earthing devices on distribution circuits with so little margin of voltage that few, if any, central station engineers dare switch on a high tension cable except through elaborate charging apparatus, the failure of these devices to act is somewhat extraordinary. The incident, however, affords no argument to the opponent of overhead lines, for it could not have happened with the standdards of switchgear and protective apparatus general in this country.

Water and Electric Supplies at Rangoon.

INTEREST attaches to a recently published report on the water supply of Rangoon, which has been prepared for the Government of Burmah by Messrs. Rendel, Tritton and Palmer, of Westminster. The report, which is now being considered by the Government, deals with a proposed hydro-electric installation at Yunzalin, in the Pegu Yoma, about 120 miles from Rangoon. It is understood that such an undertaking would be quite practicable, and that in seven years it would, if carried out, supply the city of Rangoon with sixty million gallons of water daily and twelve million kilowatt-hours of electric current. The probable cost of the scheme is given as about eight and a-quarter million pounds, and for about a further four million pounds the supplies of both water and electricity could be doubled. The plans have been also worked out for a water supply scheme alone and an electric scheme alone, but the combined hydro-electric and water supply scheme is, we are given to understand, recommended. As the greater part of the interest and depreciation costs, and the maintenance and operating charges, would, it is stated, be covered by the proposed sale of water and electric current, the scheme is one which should receive favourable consideration.

Coal Inquiry in Belgium.

IT was only the coal strike in Britain last year which saved the Belgian coal mining industry from a serious crisis. The difficulties were, however, only deferred. For some time now stocks have been piling up, and the situation has been becoming more and more acute. The trouble is exactly similar to that in this country, namely, the producing capacity of the pits cannot be sold at a remunerative price. The similarity between the two cases also extends to the fact that nobody seems able to discover a practical remedy. The Belgian Government has referred the question to a Commission of Enquiry, composed for the most part of men conversant with the problems involved, and this Commission held its first meeting on December 19th, with Monsieur Heyman, Minister of Industry and Labour, as President. In the opening speeches it was stated that three possibilities must be studied, namely, to increase the production per man, to diminish the cost of production, or to increase the value of the product. The Commission is apparently not going to consider either wages or hours of labour, these matters coming within the sphere of the National Joint Mining Commission. It was finally decided first to prepare reports dealing with problems which seemed of special urgency, namely :—(1) The consumption of coal in Belgium ; (2) the facilities granted to exporters ; (3) taxation ; (4) foreign labour in the mines ; (5) the organisation of sales of coal ; (6) questions of transportation. The discussion suggested that recommendations might ultimately be made with respect to the amalgamation of collieries ; the importation and especially the "dumping" of foreign coal ; and the use of Belgian coal by the National Railway Company and the great public service undertakings.

The Loss of the U.S. Submarine S 4

WHEN we referred a week ago to the sinking of the United States submarine S4 off Provincetown, Massachusetts, there was still a faint hope that the rescue operations would be successful in saving some of the imprisoned crew. With, however, the continuance of bad weather, all hope had to be abandoned. The gale on Wednesday of last week, December 21st, was so severe that for a time at least the wreck was lost owing to the carrying away of the marking buoy. When the position of the hull was again found, it was discovered that only a small part of the bow of the submarine remained uncovered by mud. In order to attach the chains from the lifting pontoons it will be necessary to tunnel beneath the hull. This work is being continued, but, according to some reports, it is doubtful whether it will be possible to raise the submarine before the spring of next year.

The Late Sir Frederick Young.

FEW marine engineers can claim a wider or more successful experience of salvage undertakings than could the late Sir Frederick Young, who, we regret to have to announce, died last week at his home in Chelsea, at the age of sixty-nine. Sir Frederick, or Captain Young as he was known before the war, came of a seafaring family, and, in thirty years of continuous salvage work, he was closely associated with the Liverpool Salvage Association and its salvage steamer Ranger. Although he was not far off sixty years old at the outbreak of the war, his special training enabled him within a short time to organise the whole of the Salvage Section of the Admiralty's work. We may recall the work which he did in devising boom defences for rivers and harbours, lifting submarines, including the refloating of the K 13, which sunk while on her trials in the Gareloch, and many other interesting jobs connected with the work of the Grand Fleet. With the submarine menace increased attention was paid to the salving of merchant ships and their cargo, and by the end of the war Commodore Young and the Salvage Section had to their credit the saving of 500 merchant ships, valued with their cargoes at close upon fifty million pounds. At the close of hostilities his activities were transferred to the Belgian coast, where in two years, when clearing the ports of Ostend and Zeebrugge, no less than eighteen ships were raised. For his noteworthy services Commodore Young received his K.B.E., and was the recipient of many foreign decorations. He will long be remembered, both in the Navy and the mercantile marine, for his great seamanship, his unfailing courage and determination, and a characteristic cheerfulness which continued with him until the end.

Spanish Air Services.

THE German monopoly of the air services in Spain seems to be assured by the proposal which the Superior Council of Aeronautics has submitted to the Spanish Government for the organisation of national and international lines. The national lines include those radiating from Madrid to Barcelona, Valencia, Seville, Cadiz and Vigo, and one taking in Melilla, Malaga, Ceuta, Cadiz and the Canary Islands. The international lines are from Burgos to France, Barcelona to France, Madrid to Portugal, Barcelona to Italy, and Galicia to Italy. The whole of the lines will be conceded to one company, which will have a monopoly of the traffic, and the company must be Spanish and administered by Spaniards under the control of the State, which will provide a minimum subsidy of a million and a-half pesetas. As a matter of fact, the lines mentioned are those required by the Lufthansa Company for the services it is preparing to North and South America, as well as the Madrid-Barcelona and Seville-Canary lines now in the hands of the Iberia Company, which is a subsidiary of the Lufthansa. The Madrid-Seville line is worked by the Union Aerea Espanola, a subsidiary of the Junkers Company. The Lufthansa Company is also at the back of the Seville-Buenos Aires airship scheme, which, however, is not included in the proposed monopoly, and an airship is being constructed in Germany for the opening of the service in the coming autumn, while the Junkers Company hopes to be able to organise a service with huge seaplanes. The Spanish Government is therefore really giving a monopoly to the Germans, who find that Spain is the most suitable place for taking off from Europe for the United States and South America, and who have already practically completed their arrangements for air services between Central Europe and Spain. Nevertheless, the Spanish Government is taking the necessary measures to ensure that the German companies shall eventually develop a Spanish aeroplane industry which will be able to supply a fair proportion of the machines required for the national and international lines.

Seaplane Record Speed Attempt.

THE probability that the next race for the Schneider Trophy will, in accordance with the suggestion made by the British Air Ministry, be postponed until 1929 is not likely to delay the attempt which it is understood is to be made with this year's winning machine, the Supermarine S 5, to regain the speed record for this country. It will be recalled that at Venice last September Flight-Lieut. Webster secured the Trophy with an average speed of 281·6 miles an hour over seven laps of a closed 50-kilometre circuit. Very shortly afterwards that figure as a record speed for a seaplane, or indeed for any kind of machine, was excelled by an Italian Macchi machine, which had been entered for the Schneider competition, but which had failed to complete the course. The speed set up by the Italian machine was 296·4 miles an hour. It is obvious that on a course without the numerous turnings involved in the Schneider Trophy race an increase of speed might be expected of any machine. It has for some time been confidently believed that the Supermarine S 5 is capable on a straight course of flying at over 300 miles an hour, and that there is a good prospect of this country regaining the speed record. It is to be noted that to establish an official record the machine will have to show an average speed on two flights, one with and one against the wind, exceeding the previous record by at least 5 miles an hour. The S 5 will therefore require to fly at an average speed of over 301·4 miles before the record can be re-won by it. It is interesting to note that the existing land aeroplane record speed of 278 miles an hour made by France in 1924 still stands good.

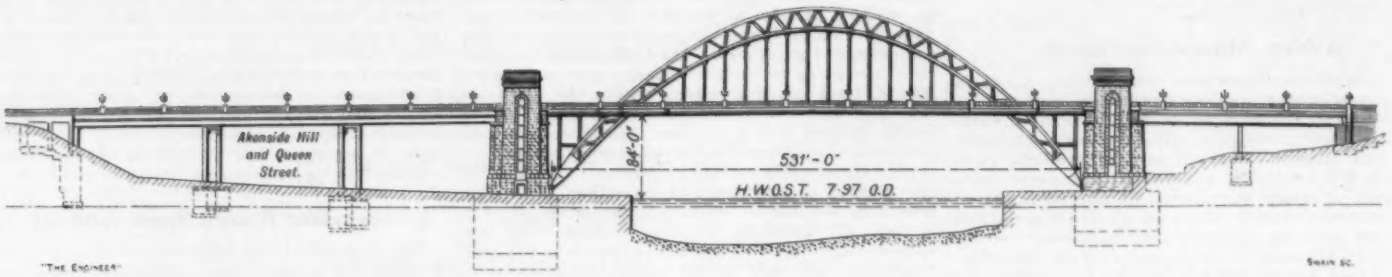
Rear-Admiral C. E. Monro.

THE retirement of Rear-Admiral C. E. Monro from the office of professional adviser in the Harbours, Foreshores and Lighthouses Department of the Board of Trade, which took place on December 23rd on his reaching the age limit, should not be allowed to pass unnoticed by engineers. For seventeen years Admiral Monro has worthily filled a position which has been occupied by a line of distinguished naval officers before him. He went to the Board of Trade with nearly thirty years' naval service, mainly in the hydrographic branch, behind him. There can be few men who possess such a knowledge of the interrelation of the work of the harbour engineer, the navigator, and the hydrographer as he has acquired during his service as adviser—a tenure, we believe, longer than that of any of his predecessors. Admiral Monro's knowledge and experience have always been at the service of harbour engineers and others engaged in connection with marine work. His advice and criticism were often sought, unofficially as well as officially, and were always given willingly and ungrudgingly. Though he comes but seldom into the public view he is well known to harbour engineers throughout the country, and his presence at the Board of Trade will be missed by them. Admiral Monro's successor is Commander V. R. Brandon, R.N.

Thames Bridges.

WHILE the report of the engineers on the Charing Cross Bridge scheme is being awaited, the Bridge House Estates Committee has been examining another of the schemes favoured by the Royal Commission on Cross-River Traffic, namely, the construction of a new bridge at Ludgate. It has adopted a report submitted by a sub-committee in which the Ludgate Bridge scheme is compared with the St. Paul's Bridge scheme and is found wanting. The St. Paul's Bridge scheme has been long in existence and considerable sums, principally by way of the purchase of property on the route of the bridge approaches, have already been expended in connection with it. If the scheme is now abandoned in favour of the Commission's Ludgate Bridge there will be a substantial loss of money. In addition, the sub-committee argues that the Ludgate Bridge scheme has been hastily conceived, is unsuitable in its route, and impossible to carry out at anything like the cost indicated in the Commission's report. As regards St. Paul's Cathedral, the sub-committee holds that neither scheme would endanger the fabric by vibration or by the construction of the piers. The route proposed for the Ludgate Bridge scheme would be further away from the cathedral than that planned for the St. Paul's Bridge, but the northern abutment of both bridges would be practically at the same distance from the nearest point of the cathedral. The Court of Common Council of the City of London is to be asked to authorise the Bridge House Estates Committee to consider and report on the whole question of cross-river traffic within the City area.

NEW ROAD BRIDGE BETWEEN NEWCASTLE AND GATESHEAD



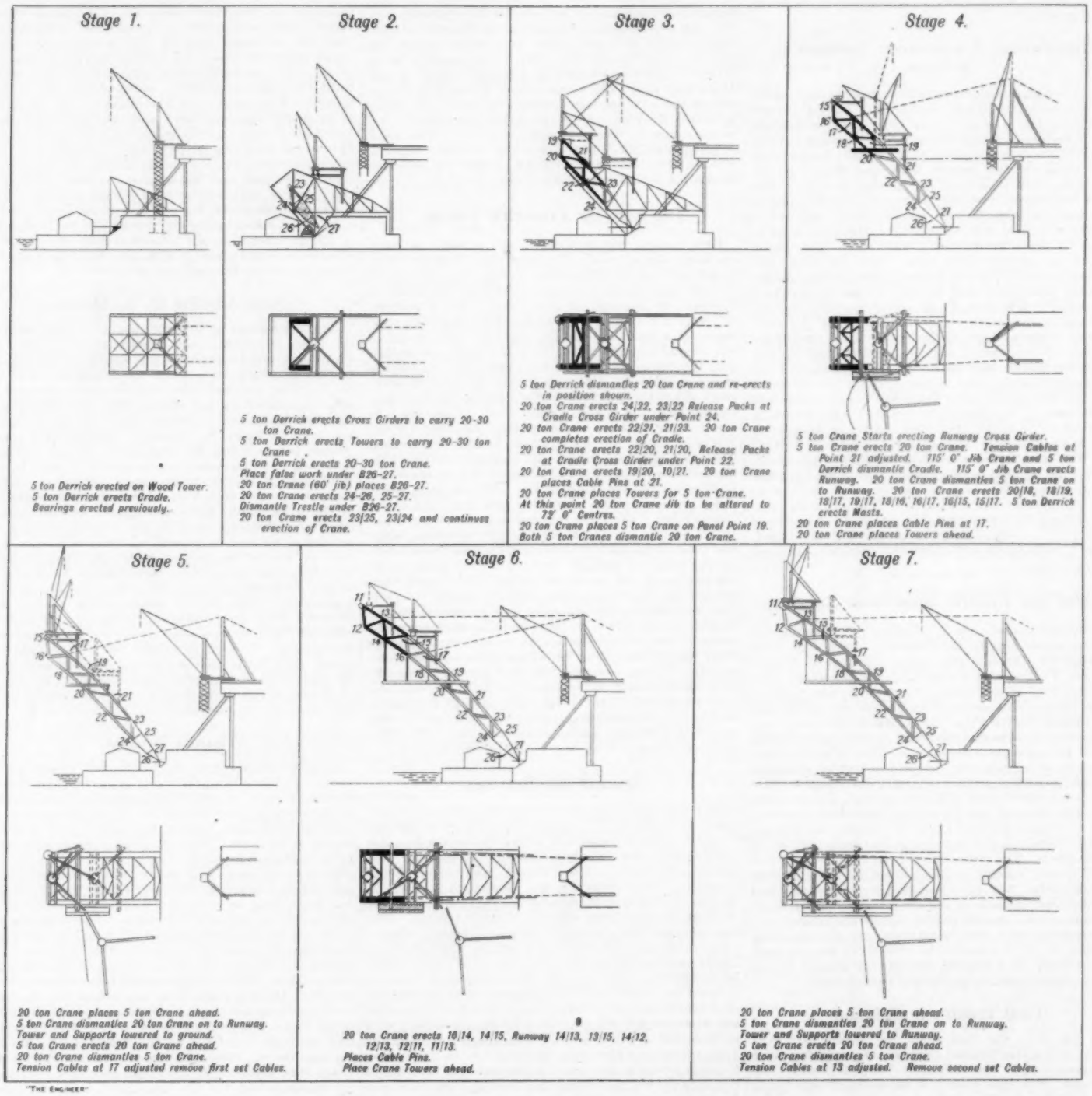
Newcastle-Gateshead Bridge.

THE new road bridge at present under construction between Newcastle and Gateshead consists of a single arch over the river Tyne, with approach spans on both sides of the river. An outline of it is shown above. The roadway is situated 93ft. above high water level and allows a clear height for shipping of 84ft. The approaches to the bridge commence on the Newcastle side in Pilgrim-street, and terminate in Gateshead in a direct line with High-street. The new structure thus provides a direct route between important streets in the two towns. The gradients are easy, being 1 in 66·4 on the Newcastle approach, and 1 in 91·5 on the Gateshead approach; the length over the arch being graded to a very flat parabolic curve. The width of the carriageway is 38ft., and each footway allows for a clear breadth of 9ft. The carriageway will include a double tramway track, thus connecting the tramway systems on each side of the river.

In addition to the standard Ministry of Transport loading, an exceptional load of 100 tons on four wheels is allowed for in anticipation of very heavy traffic to be met with in this industrial area.

The abutments, which take the thrust of the steel arch, have all been carried down to solid rock, which has been reached at — 60 O.D. in Newcastle and at — 40 O.D. in Gateshead. These foundations consist of four masses of concrete, 84ft. 6in. long by a width, measured at right angles to the centre line of the arch, of 28ft., and are from 60ft. to 80ft. overall depth. They were sunk by means of caissons under compressed air, and are placed one at each of the four feet of the arch.

The arch, which, when completed, will be the largest in the country, is of mild steel, two-hinged type, with a span from pin to pin of 531ft., and a rise of 170ft. It consists of two crescent-shaped ribs at 45ft. centres, each rib composed of upper and lower booms of parabolic outline, with single bracing of the Warren type. The depth between booms at the centre is 20ft. 3in. The ribs are connected by lateral and sway bracing,


Stage 1.
5 ton Derrick erected on Wood Tower.
5 ton Derrick erects Cradle.
Bearings erected previously.
Stage 2.
5 ton Derrick erects Cross Girders to carry 20-30 ton Crane.
5 ton Derrick erects Towers to carry 20-30 ton Crane.
5 ton Derrick erects 20-30 ton Crane.
Place false work under B26-27.
20 ton Crane (60' jib) places B26-27.
20 ton Crane erects 24-26, 25-27.
Dismantle Trestle under B26-27.
20 ton Crane erects 23|25, 23|24 and continues erection of Crane.
Stage 3.
5 ton Derrick dismantles 20 ton Crane and re-erects in position shown.
20 ton Crane erects 24|22, 23|22 Release Packs at Cradle Cross Girder under Point 24.
20 ton Crane erects 22|21, 21|23. 20 ton Crane completes erection of Cradle.
20 ton Crane erects 22|20, 21|20, Release Packs at Cradle Cross Girder under Point 22.
20 ton Crane erects 19|20, 10|21. 20 ton Crane places Cable Pins at 21.
20 ton Crane places Towers for 5 ton Crane.
At this point 20 ton Crane Jib to be altered to 72' 0" Centres.
20 ton Crane places 5 ton Crane on Panel Point 19.
Both 5 ton Cranes dismantle 20 ton Crane.
Stage 4.
5 ton Crane Starts erecting Runway Cross Girder.
5 ton Crane erects 20 ton Crane. Tension Cables at Point 21 adjusted. 115' 0" Jib Crane and 5 ton Derrick dismantle Cradle. 115' 0" Jib Crane erects Runway. 20 ton Crane dismantles 5 ton Crane on to Runway. 20 ton Crane erects 20|18, 18|19, 18|17, 19|17, 18|16, 16|17, 16|15, 15|17. 5 ton Derrick erects Masts.
20 ton Crane places Cable Pins at 17.
20 ton Crane places Towers ahead.
Stage 5.
20 ton Crane places 5 ton Crane ahead.
5 ton Crane dismantles 20 ton Crane on to Runway.
Tower and Supports lowered to ground.
5 ton Crane erects 20 ton Crane ahead.
20 ton Crane dismantles 5 ton Crane.
Tension Cables at 17 adjusted remove first set Cables.
Stage 6.
20 ton Crane erects 16|14, 14|15, Runway 14|13, 13|15, 14|12, 12|13, 12|11, 11|13.
Places Cable Pins.
Place Crane Towers ahead.
Stage 7.
20 ton Crane places 5 ton Crane ahead.
5 ton Crane dismantles 20 ton Crane on to Runway.
Tower and Supports lowered to Runway.
5 ton Crane erects 20 ton Crane ahead.
20 ton Crane dismantles 5 ton Crane.
Tension Cables at 13 adjusted. Remove second set Cables.
"THE ENGINEER"

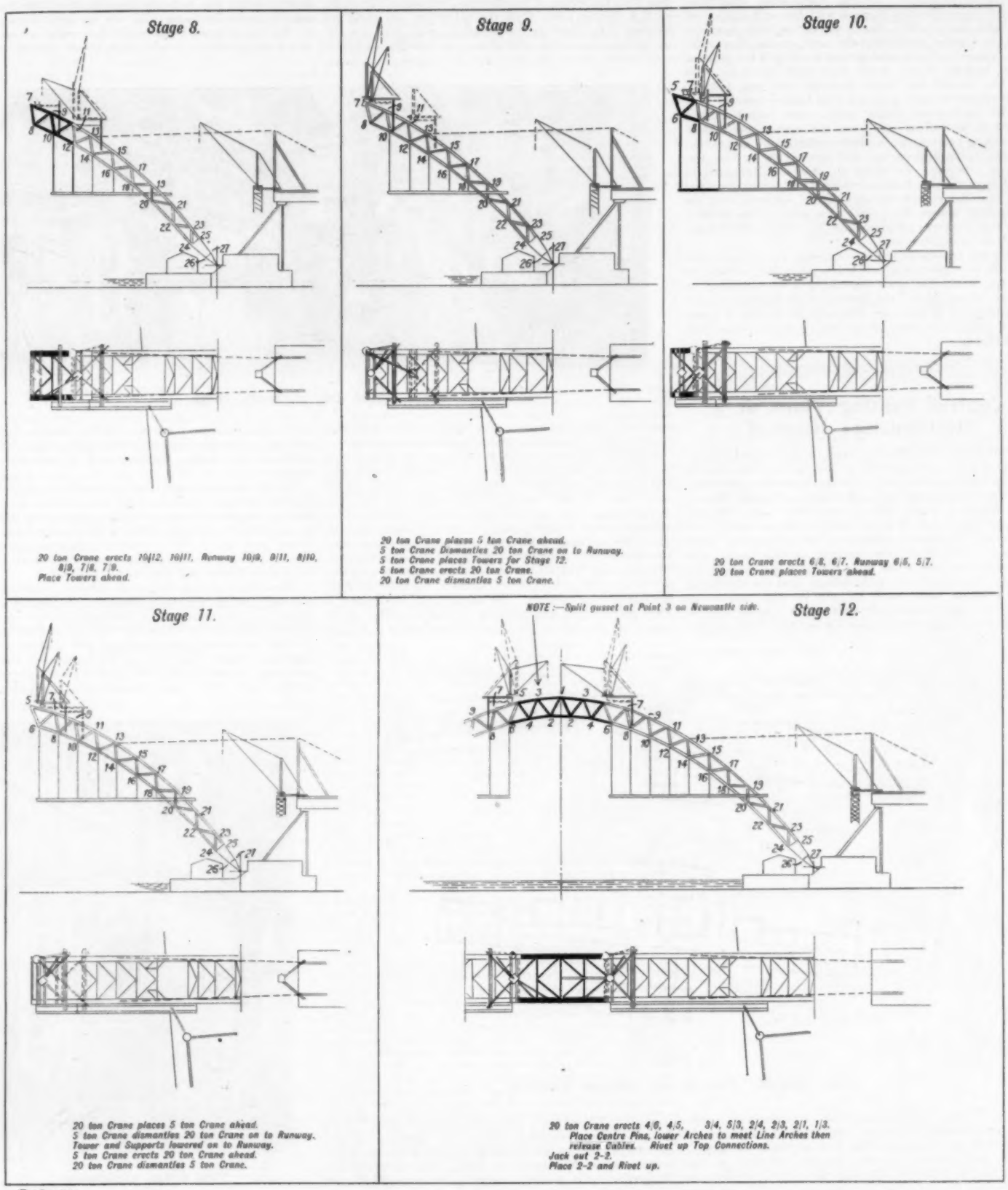
DIAGRAMS SHOWING STAGES IN THE ERECTION OF THE BRIDGE

the lateral bracing being in "K" formation. Towards the abutments the roadway is carried on columns supported on the upper booms of the ribs, while in the centre it is suspended by hangers from the lower booms.

The abutments will be carried up from quay level to bridge roadway level. This portion of the work will be of steel and concrete construction, faced with granite, and as these towers will be hollow and of large dimensions, being about 100ft. long, 60ft. wide octagonal in section, are built up with a skin of steel plates, strengthened by rolled steel joists and filled in with concrete.

Earth approaches retained by concrete walls, partly masonry faced, have been provided on each approach between existing street surfaces and the continuous girder spans. On both sides this construction extends for approximately 200ft.

The carriageway will be surfaced in wood block paving, resting on concrete, and the footways in tar-


Stage 8.
20 ton Crane erects 10/12, 10/11, Runway 10/9, 9/11, 8/10, 8/9, 7/8, 7/9. Place Towers ahead.
Stage 9.
20 ton Crane places 5 ton Crane ahead.
5 ton Crane Dismantles 20 ton Crane on to Runway.
5 ton Crane places Towers for Stage 12.
5 ton Crane erects 20 ton Crane.
20 ton Crane dismantles 5 ton Crane.
Stage 10.
20 ton Crane erects 6/8, 6/7. Runway 6/5, 5/7.
20 ton Crane places Towers ahead.
Stage 11.
20 ton Crane places 5 ton Crane ahead.
5 ton Crane dismantles 20 ton Crane on to Runway.
Tower and Supports lowered on to Runway.
5 ton Crane erects 20 ton Crane ahead.
20 ton Crane dismantles 5 ton Crane.
NOTE:—Split gusset at Point 3 on Newcastle side.
Stage 12.
20 ton Crane erects 4/6, 4/5, 3/4, 5/3, 2/4, 2/3, 2/1, 1/3.
Place Centre Pins, lower Arches to meet Line Arches then release Cables. Rivet up Top Connections.
Jack out 2-2.
Place 2-2 and Rivet up.
"THE ENGINEER"

DIAGRAMS SHOWING STAGES IN THE ERECTION OF THE BRIDGE

and 90ft. high, it is proposed that they should be used as warehouses. A further extension upwards will consist of towers on each side of the bridge to a height of nearly 40ft. above the level of the road. Stairways and lifts will afford access between quay level and the bridge roadway.

The approaches on each side of the arch are carried by continuous girders at 34ft. centres, supported on steel columns. The spans vary from 100ft. to 154ft., the variation being due to the situation of adjacent streets and buildings. These girders are of twin plate web form, 11ft. 6in. over angles. The columns, macadam. Over the arch and continuous girder spans, the surface rests on buckled steel plates supported on cross joists and longitudinal stringers, which, in turn, are supported on the cross girders. The footways are carried on brackets cantilevered out from the cross girders.

The contractors for the work are Dorman, Long and Co., Ltd., Middlesbrough, and the erection scheme has been got out by them to the design of their consulting engineers, Mr. Ralph Freeman and Mr. G. C. Imbault.

At the present moment, the arch ribs are being built out from all four hinges. In the initial stages this work is accomplished by the use of a cradle on which the ribs rest. As erection proceeds, the weight of the ribs is transferred from the cradle to cables which are connected to the top boom. These cables are carried back over temporary masts, erected on the river ends of the approch spans, and connected to the webs of the approach spans. The cable tension is resisted by the deadweight of these girders in conjunction with raking struts which are necessary to prevent the girders being dragged riverwards.

When the two halves of the arch have been completed, with the exception of the centre panel of the lower boom of the arch ribs, the cables will be slackened off, thus allowing the top chords to meet, and a temporary pin will transfer the thrust between the two halves of the upper chords. At this stage, the arch will be actually three-hinged. The centre panels of the lower chords will then be raised into position, and, by hydraulic jacking, a definite compression will be applied between this member and its adjacent chord, thus putting the arch into a true

two-hinged condition. Carefully shaped fillers will be inserted, the joint practically completed and the jacks removed. The various stages of erection are illustrated herewith, and a series of views of the bridge showing the state of erection reached a few weeks ago appears on page 740. Of these engravings, the first, which is a view taken from the river of the Gateshead abutment, shows the arch erected to p.p. 19–20, and the first set of cables in position. It illustrates the completion of Stage 3, as shown in the accompanying diagrams. Fig. 2, which is also of the Gateshead abutment, looking north-west, illustrates the commencement of Stage 4, with the arch supported by cables at p.p. 21. Fig. 3 shows the main bearings and the bottom sections of the arch, on the Newcastle side, supported on a timber trestle. Fig. 4 is a general view, looking north, of the Newcastle abutment, and it, too, shows the main bearings and the bottom sections of the arch supported on timber trestles.

The continuous girder spans were launched into position by rolling out from the earth approaches. As rolling proceeded, further sections were assembled on the earth approaches and riveted on to the preceding sections. In order to ease the difficulty of bridging the span between the columns during rolling out, the deck steel work carrying the roadway over the abutment towers was used as a nose to the girders, and this nose was supplemented by a light steel framework at its extreme end.

We are indebted for the foregoing particulars, and for the illustrations which accompany this article, to Messrs. Mott, Hay and Anderson, of Westminster, to whose designs, in conjunction with Messrs. Coode, Fitzmaurice, Wilson and Mitchell, the bridge is being built, and for whose courtesy we desire to tender our best thanks.

Central Heating Plant at a Hertfordshire Hospital.

THE West Hertfordshire Hospital at Hemel Hempstead, which celebrated its centenary in 1926, consists of the old main building, having basement, principal floor and small first floor, the Halsey Nurses' Home, the Windsor ward, with ground floor only, erected during the Great War, a small isolation ward, and the new Marnham maternity ward recently completed. In 1925 the heating arrangements and domestic hot-water supplies became inadequate for the 130 occupants of the buildings, and the sterilising and cooking were done by gas at high cost. In order to provide adequate services, it was decided to remove the independent heating and hot-water boilers and to connect the heating, hot-water services, cooking and sterilising to a new central plant which would raise sufficient steam to deal with all these services.

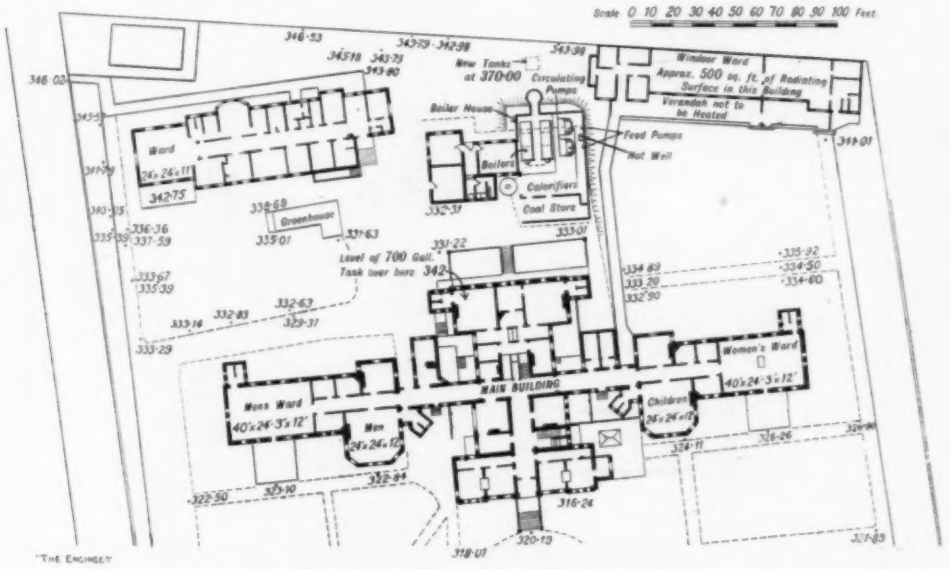


FIG. 1—GENERAL PLAN OF THE HOSPITAL BUILDINGS

The site proved to be one of great difficulty, as the buildings are placed upon ground which rises from the nurses' home to the Windsor ward, with a gradient of 1 in 12. The idea of gravity flow and return for the hot water heating to a boiler-house at the bottom of the gradient proved impossible, and it was decided to exclude the nurses' home from connection with the new plant, and to erect a new boiler-house on vacant ground between the main building and the Windsor ward—see Fig. 1. This arrangement, however, ruled out any possibility of gravity circulation for the heating and domestic hot-water supplies, and forced circulation had to be employed. The work was badly impeded by the general strike of 1926, but the plant was finally put into commission in June, 1927. The consulting engineer for the works was Mr. H. A. Sandford, of 23, Bush-lane, E.C. 4, and the contract was placed in the hands of the London Plenum Heating Company, of 223, Ebury-street, S.W. 1, the boiler-house and ferro-concrete chimney being erected under the care of Messrs. Paine and Hobday, F.R.I.B.A., of Westminster, architects to the hospital, in accordance with particulars supplied by the engineer.

The plant in the new boiler-house consists of two Cornish boilers—see Fig. 2—each 6ft. diameter by 18ft. long, having a working pressure of 80 lb. per square inch, made by Yates and Thom, Ltd., of Blackburn. Each boiler will provide sufficient steam to deal with the whole of the services, but one is equipped with a shorter grate than the other for use when no heating is required in the building, and, with a view to further economy in working, each boiler is fitted with a Hodgkinson's mechanical stoker of the sprinkler type, so as to enable low-grade fuel to be consumed.

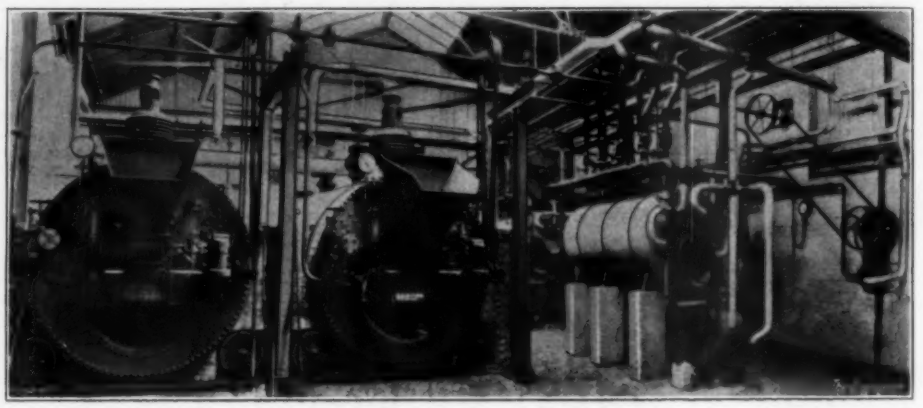


FIG. 2—BOILER AND CALORIFIER HOUSE

From the boilers live steam is taken to the pumps required for the circulation of the heating water and the domestic hot water. These pumps are in duplicate—two for the heating water and two for the domestic hot water, each pump being capable of the full duty, one being a spare in case of breakdown of the other. Each pump for the heating water is a 2in. diameter "Mopump," made by Messrs. Rhodes, Brydon and Youatt, of Stockport, and is coupled direct to a 1¼ H.P. Turney turbine, running at 2000 revolutions per minute. The capacity of each pump is 3000 gallons per hour against a head of 18ft. Each pump for circulating the domestic hot water is a 1¼in. diameter "Mopump," likewise coupled direct to a ¾ H.P. Turney turbine, and has a capacity of 300 gallons per hour when running at 2000 revolutions per minute against a head of 18ft. The turbines are designed to run under a steam pressure of 80 lb. per square inch with a back pressure of 5 lb.

Two calorifiers are provided—see Fig. 3—one for heating water for radiators and the other for heating domestic hot water. The heating calorifier is of the horizontal storage type, 3ft. diameter and 5ft. long, with a capacity of 150 gallons, made of galvanised wrought steel tested hydraulically to 25 lb. pressure. The steam boxes with covers and floating heads are of cast iron and carry two independent banks of copper tubes expanded into the steam boxes and floating heads. One bank of tubes carries live steam at 80 lb. pressure, and the other exhaust steam at 5 lb. pressure from the steam turbine driving the circulating pump in use. When provided with 680 lb. of live steam and 300 lb. of exhaust steam per hour, the capacity of this calorifier is 866,000 B.Th.U. per hour, sufficient to provide for the heating surface in the buildings. The calorifier for the domestic hot water is of similar design, and is rated at 600,000 B.Th.U. per hour, sufficient to raise 600 gallons of water from 50 deg. to 150 deg. Fah. when supplied with 370 lb. of live and 290 lb. of exhaust steam per hour.

Both calorifiers were made by Frank Pearn and Co., Ltd., of Manchester, and are fitted with two Euston-type thermostatic control valves on each, one on the live and one on the exhaust steam inlets. Interchange pipes can be inserted between the calorifiers, so that when one is being cleaned the other may be used temporarily to carry on the services; the control of the heating and domestic hot water circuits is operated by valves in the pipes above the calorifiers, where thermometers are provided to enable the engineer-in-charge to check the flow and return temperatures on the various heating and hot-water supply mains.

The boiler-feed pumps are in duplicate, each being of the Donkey type with fly-wheel, having a 5in. steam cylinder by 5in. stroke and 2¾in. ram, and each is capable of feeding both boilers simultaneously. These and the 2 H.P. vertical reciprocating steam wall engine for the mechanical stokers were also made by Frank Pearn and Co., Ltd.

The whole of the live and exhaust steam passed through the calorifiers is returned to the 400-gallon hotwell or feed tank, and a 2000-gallon blow-off sump is provided, whilst cold water storage of 2000 gallons for the domestic hot water and 500 gallons for the heating—which also acts as an expansion tank—is provided in tanks mounted upon a steel water tower at the back of the boiler-house. The covering of the boilers, calorifiers and piping was done by the Apex Insulation Company, of London. All connections are arranged so that any pump may be used with either boiler or calorifier, and thus the chances of failure of the vital services are reduced to a minimum.

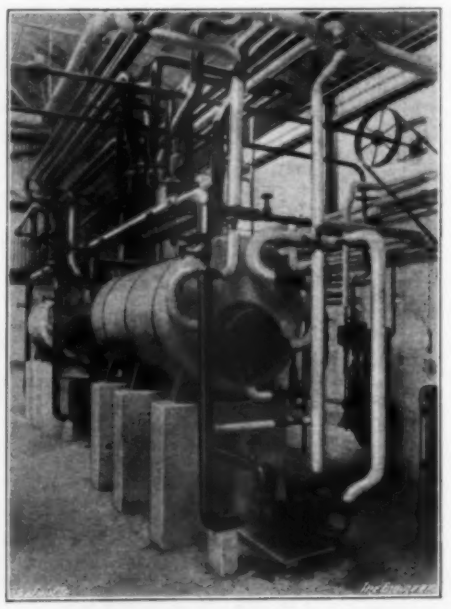


FIG. 3—THE CALORIFIERS

The heating of the buildings connected to the central plant is carried out by hot water circulated through pipes and radiators. In the main building, the original system consisted of a low-pressure gravity system of twenty radiators having a total heating service of about 900 square feet, and to these were added, in order to give a temperature of 60 deg. Fah. inside when the outside temperature is 30 deg., radiators which, with piping, give a total heating surface of about 3300 square feet. In the operating theatre

a radiator connected to the domestic hot water service so as to be available at all times, was added as a supplementary unit to the other radiators. In the Windsor ward a low-pressure drop system of pipes and radiators, having a total heating surface of about 500 square feet, already sufficient for the desired temperature, was connected up to the new central plant, as also was that in the isolation ward, which had a heating surface of about 250 square feet.

In the Marnham ward a flow and return pipe system with radiators was installed, having a total heating surface of 750 square feet to give the specified temperature, whilst in the labour room, where 70 deg. are required, part of the radiator heating surface was connected to the domestic hot water service for use in summer when the heating calorifier is not in use. Radiators on the domestic hot water are also fitted in certain airing cupboards for use under similar conditions.

Live steam is carried at full pressure to the kitchen in the basement of the main building, where it is reduced to a pressure of 10 lb per square inch for the cooking plant, which consists of two 30-gallon steam-jacketed boiling pans and one 30-gallon water-jacketed pan for boiling milk. There is also a hot plate and closet, 6ft. long by 2ft. 6in. wide, with a two-compartment steam oven, each compartment being 30in. high, 18in. wide and 24in. deep, all being made by the Falkirk Iron Company, Ltd. The products of condensation are returned by lifting traps to the feed tank in the boiler-house.

Live steam is also conveyed at 50 lb. per square inch pressure to sterilising apparatus in the various buildings. The most important of these are a dressing steriliser, 2ft. 6in. diameter by 4ft. long, large bowl and instrument sterilisers and one 10-gallon water steriliser in the main building, and also in the Marnham ward, made by Manlove, Alliott and Co., Ltd., together with smaller water and instrument sterilisers made by J. and A. Carter, Ltd., for the duty rooms. Steam is also supplied to a small laundry and to a number of drying cupboards.

The total cost of the works, including all equipment and additions to the electric light and power services, bells and telephones, for which Mr. Sandford was also responsible, exceeded £4500, exclusive of buildings. We may add that the cubic contents of the buildings heated is approximately 225,000 cubic feet, and that the area of glass in the windows is in the region of 4000 square feet.

Some Experimental Results from a Three-cylinder Compound Locomotive.*

By LAWFORD H. FRY.

(*Concluded from page 720*).

Cylinder Efficiency.—The steam rate per indicated horse-power hour is shown in Fig. 6 in relation to the horse-power developed. The curve obtained is much flatter than is usual with locomotives. The extreme range of the steam rate is from a maximum of 16·6 lb. per I.H.P. hour at

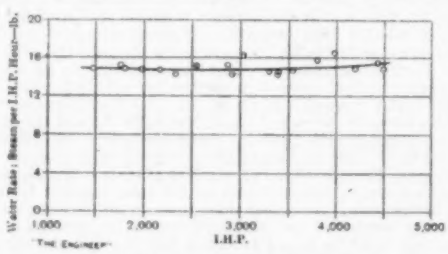


FIG. 6—STEAM RATE PER INDICATED HORSE-POWER

120 r.p.m. and 90/70 per cent. cut-off—90 per cent. in the high-pressure and 70 per cent. in the low-pressure cylinders—to 14·2 lb. per I.H.P. hour at 120 r.p.m. and 70/40 per cent. cut-off. This last figure is the lowest obtained with any locomotive on the Altoona test plant. The steam rate at the maximum power of 4500 I.H.P. was 15·15 lb. per I.H.P. hour. This was the average from two tests each of one hour's duration run at 200 r.p.m.—37·5 miles per hour—and 80/50 per cent. cut-off. Curves for the draw-bar

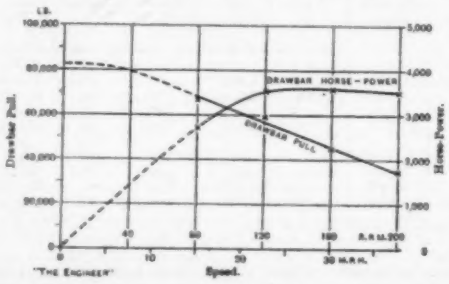


FIG. 7—DRAWBAR HORSE-POWER AND DRAWBAR PULL

horse-power and draw-bar pull measured on the locomotive test plant are given in Fig. 7. Measurements of the draw-bar pull by dynamometer car on road tests give slightly higher figures.

* The Institution of Mechanical Engineers. Dec. 16, 1927.

In order to obtain further details as to the steam action in the cylinders and to establish if possible the reason for the unusually flat steam rate curve, the analysis described below was carried out. Eight tests were selected with cut-offs and speeds varying to cover the range through which the locomotive was tested. These tests are divisible into two groups, one with a constant speed of 80 r.p.m. and cut-offs of 90/70, 80/50, 70/40, 60/30, and 50/20 per cent., the other group with a constant cut-off of 70/40 per cent. and speeds of 80, 120, 160, and 200 r.p.m. The tests ranged in duration from twenty minutes to two and one-quarter hours. During each test the speed and cut-off were kept perfectly uniform, while indicator cards were taken every five minutes. Unless otherwise stated, values attributed to the cards are averages of all the head and crank end cards taken during a test. The water delivered to the boiler was accurately measured by weighing and careful allowance was made for any water diverted, so that the figures given for cylinder feed represent accurately the weight of steam actually delivered to the engine. For tests of this description the locomotive testing plant has a great advantage over road tests. It is comparatively easy on the plant to maintain speed and cut-off unchanged for an hour at a time, to take indicator cards at frequent intervals, and to determine accurately the water and coal used. A recent paper† by Mr. E. L. Diamond on an English compound locomotive suffered from the fact that the cards analysed were obtained during road tests and consequently the steam consumption could only be estimated and not measured.

TABLE I.—*Experimental Data.*

Group.	1 Test No.	2 Test designation.	3 Boiler pressure, lb. per sq. in. abs.	4 Branch pipe. Pressure, lb. per sq. in. abs.	5 Branch pipe. Temp., deg. F.	6 Branch pipe. Superheat, deg. F.	7 Steam supplied to engine. lb. per hr.	8 Steam supplied to engine. lb. per stroke.	9 Indicated horse-power.	10 Steam per I.H.P. per hour.
1	7,922	80–90/70	363	346	638	207	49,485	5·09	3,034	16·3
	7,906	80–80/50	359	344	635	205	38,863	4·05	2,560	15·2
	7,911	80–70/40	363	351	600	168	32,003	3·33	2,164	14·8
	7,910	80–60/30	363	353	584	151	26,740	2·79	1,763	15·2
	7,912	80–50/20	361	353	568	135	21,882	2·28	1,471	14·9
2	7,911	80–70/40	363	351	600	168	32,003	3·33	2,164	14·8
	7,913	120–70/40	364	347	634	203	41,376	2·87	2,914	14·2
	7,926	160–70/40	361	341	653	224	48,323	2·52	3,304	14·6
	7,925	200–70/40	361	335	674	246	59,931	2·50	3,804	15·8

Table I. gives the weight and condition of steam delivered to the cylinders as given in Table I. The first column gives the test number and the second a test designation made up of the speed in r.p.m. and the cut-off. Thus test 7911, which appears in both groups, has the designation 80–70/40, indicating 80 r.p.m. with cut-off at 70 per cent. in the high-pressure and 40 per cent. in the low-pressure cylinders. Table I. has been compiled to show the weight of cylinder feed supplied per hour and per stroke; the pressure in the boiler; the pressure, temperature and superheat in the branch pipe; and the indicated horse-power and weight of steam per indicated horse-power. In all eight tests the boiler pressure is close to the nominal working pressure of 364 lb. per square inch absolute—350 lb. per square inch gauge—but the branch pipe pressure varies with the rate of steam flow owing to the wire-drawing through the superheater. Thus in test 7912 with 21,882 lb. of steam per hour the drop between boiler and branch pipe is 8 lb., while in test 7925 with 59,931 lb. of steam per hour the drop is increased to 26 lb. per square inch. Other tests are intermediate between these extremes. The superheat also varies with the rate of steam flow. At the lowest rate of flow, test 7912, the superheat is 135 deg. Fah., while at the maximum, test 7925, it is as much as 246 deg. Fah. This increase in superheat is due to the higher fire-box temperatures at the higher rates of evaporation. The change in branch pipe pressure and temperature affect the cylinder efficiency though they are due to boiler conditions only. Such changes in boiler conditions are, however, inseparable from changes in speed and cut-off, since the rate at which steam is taken from a locomotive boiler is determined by the speed and cut-off of the engine, and the fire-box temperature and the pressure drop through the superheater are dependent on the boiler output.

As a first step in the study of the effect of cylinder conditions on cylinder efficiency the actual indicator diagrams are compared with theoretical modified Rankine diagrams in Fig. 8. The effect of the compression steam has been eliminated from the indicator diagrams by setting all abscissæ to the left so as to make the compression and admission lines a single vertical straight line. The low and high-pressure cards are combined by making the abscissæ scale of the low-pressure twice that of the high-pressure card, and each combined card is enclosed in a diagram for a modified Rankine cycle. These diagrams are drawn by plotting a point to represent the volume and pressure of the cylinder feed under branch pipe conditions. A horizontal through this point gives the admission line and an adiabatic the expansion line. The release line is obtained by drawing a vertical through the extreme toe of the low-pressure card and a horizontal through the least back pressure gives an exhaust line to close the diagram. The diagram thus obtained represents by its area the theoretical maximum amount of work which can be obtained by admitting steam at branch pipe conditions, expanding it to the greatest volume reached by the working steam in the actual cycle and then releasing to and expanding at the lowest actual exhaust pressure. The author has shown elsewhere† that the work represented by this diagram is given by the equation

$$W = H_s - H_r + 0{\cdot}1852\,(P_r - P_e)\,V_r$$

Where W is the work developed in B.Th.U.;
H_s is the total heat on admission in B.Th.U. per pound;
H_r is the total heat at release in B.Th.U. per pound;
P_r is the pressure at release in pounds per square inch absolute;
P_e is the pressure during exhaust in pounds per square inch absolute; and
V_r is the specific volume at release in cubic feet per pound.

As a standard of comparison for a locomotive cylinder this modified Rankine cycle has advantages over the regular Rankine cycle. As a matter of convenience it is referred to hereafter as the "locomotive cycle." The full Rankine cycle takes into account only the pressure and temperature at admission and the pressure at exhaust, assuming that adiabatic expansion is continuous from the admission to the exhaust pressure. This requires a ratio of expansion much higher than is at all practicable in locomotive work. The locomotive cycle, on the other hand, allows the actual amount of expansion to be taken into account. The difference between the Rankine and the locomotive cycles is illustrated by the following figures taken from test No. 7913, 120–70/40.

The steam conditions in this test were:—

Branch pipe pressure	347 lb. per sq. in. absolute
Branch pipe superheat	203 deg. Fah.
Total heat in steam at admission	1330 B.Th.U. per lb.
Exhaust pressure	19 lb. per sq. in. absolute
Steam per I.H.P. per hour, measured	14·2 lb.
Steam per stroke	2·87 lb

From these figures the following are derived:—

	Full Rankine cycle.	Theoretical locomotive cycle.	Actual indicator cards.
Heat transformed to work per lb. of steam, B.Th.U.	239	210	180
Steam used per I.H.P. per hour, lb.	9·4	21·1	14·2
Cylinder efficiency, per cent.	18·0	15·9	13·6
Relative efficiencies	100 / —	87 / 100	75 / 86
Number of expansions	11·3	3·4	3·4

Here, with 1330 B.Th.U. carried into the cylinder by each pound of steam, the heat converted into external work

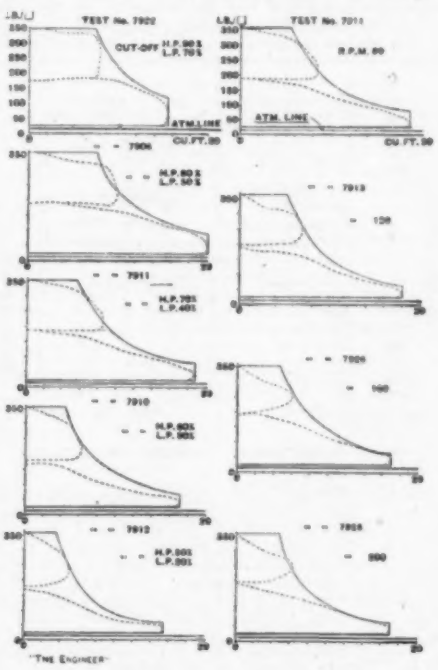


FIG. 8—COMBINED INDICATOR DIAGRAMS

was 180 B.Th.U. per pound in the actual test, and would be 210 B.Th.U. in the locomotive cycle and 239 B.Th.U. in the full Rankine cycle. The relative efficiencies in this test were:—

	Per cent.
Rankine cycle	100
Locomotive cycle	87
Actual cards	75

The full Rankine cycle requires 11·3 expansions, while the actual number was only 3·4, so that with over three times the number of expansions the Rankine cycle shows an efficiency only 13 per cent. greater than the locomotive cycle. This 13 per cent. represents the area lost in the extreme toe of the Rankine diagram. To utilise

* "Proc.," I. Mech. E., 1927, Vol. i., page 465.

† American Society of Mechanical Engineers, May, 1927.

this as effective work would require the cylinder volume to be more than tripled. It is evident, in view of the small gain and of the much greater complications in valve gear and much larger cylinders required, that there is little practical advantage in attempting to approximate in locomotive practice the high expansion ratio of the Rankine cycle. It therefore follows that the use of the Rankine cycle as a basis of comparison in locomotive work gives a misleadingly low value for efficiency obtained. In other words, the Rankine cycle with adiabatic expansion from admission to exhaust sets up a standard which is not only unattainable in practice, but which it would not be desirable to attempt to attain because of the very high ratio of expansion which would be required. The locomotive cycle diagram, on the other hand, represents the maximum amount of work theoretically obtainable with the actual values for admission pressure and temperature, exhaust pressure and ratio of expansion. It is therefore proper to expect the area of the actual cards to be a fairly high percentage of the area of the locomotive cycle diagram.

As explained above, the actual indicator cards have been enclosed in locomotive cycle diagrams in Fig. 8. Information relating to or derived from these theoretical diagrams is given in Table II. For each diagram the amount of cylinder feed, Column 8, Table I., is assumed to be admitted at branch pipe pressure and temperature, Columns 4 and 5, Table I. The corresponding volume found from these data and the steam tables* is taken as the volume at admission, and is recorded in Column 3, Table II. The volume at release, Column 4, Table II., is taken from the corrected indicator cards and is the greatest volume occupied by the cylinder feed exclusive of clearance steam. The volume at release divided by the volume at admission gives the number of expansions, Column 5, Table II. As adiabatic expansion is assumed and the initial pressure and quality are known, the pressure and quality at release, Columns 6 and 7, Table II., can be found from the steam tables. The remaining columns of Table II. show the total heat per pound of steam at branch pipe pressure and temperature, the heat converted to work per pound of steam in the locomotive cycle, the heat shown by the indicator cards to be converted to work per pound of cylinder feed, the cylinder efficiency of the locomotive cycle, the cylinder efficiency of the actual indicator cards and the ratio of the actual to the theoretical cylinder efficiency. The information regarding the cylinder efficiencies, both actual and theoretical, is plotted in Fig. 9.

TABLE II.—*Data for Locomotive Cycle Diagrams and Cylinder Efficiencies.*

1	2	3	4	5	6	7	8	9	10	11	12	13
Test No.	Test designation.	Steam volumes in cubic feet.		Number of expansions Col. 4 ÷ Col. 3.	At release.		Total heat per lb. steam.			Cylinder efficiency.		Ratio of actual to theoretic. Efficiency, per cent.
		At admission.	At release.		Pressure, lb. per sq. in. abs.	Superheat or dryness.	At admiss., B.Th.U.	Converted to work.		Loco. cycle.	Indic. cards.	
								Loco. cycle.	Indic. cards.			
7,922	80–90/70	10·0	20·9	2·1	116	51°	1,332	179	156	13·5	11·7	87·4
7,906	80–80/50	7·7	20·0	2·6	88	22°	1,329	193	168	14·6	12·7	87·0
7,911	80–70/40	5·8	18·7	3·2	76	0·982	1,310	200	172	15·3	13·2	86·5
7,910	80–60/30	4·7	17·2	3·7	64	0·967	1,300	208	168	16·0	12·9	80·5
7,912	80–50/20	3·8	15·5	4·1	60	0·955	1,291	208	171	16·1	13·3	82·3
7,911	80–70/40	5·8	18·7	3·2	76	0·982	1,310	200	172	15·3	13·2	86·5
7,913	120–70/40	5·2	18·0	3·4	64	0·988	1,330	210	180	15·9	13·6	85·5
7,926	160–70/40	4·9	17·1	3·5	62	0·998	1,341	209	175	15·6	13·1	84·0
7,925	200–70/40	4·9	17·1	3·5	8•	10°	1,351	206	161	15·3	12·9	78·5

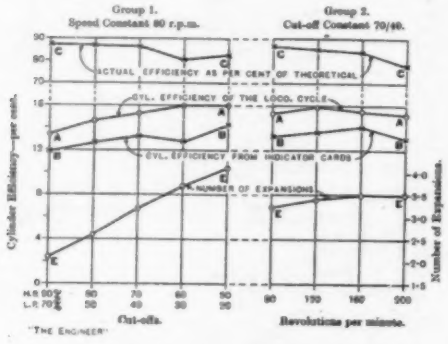


FIG. 9—VARIATION IN CYLINDER EFFICIENCIES

In the tests of Group 1 with constant speed the theoretical efficiency, line AA of the locomotive cycle, increases as the cut-off is shortened and the number of expansions increases. The actual cylinder efficiency shown by the indicator cards, line BB, follows generally the same course, but does not rise quite so rapidly. At the long cut-off the actual efficiency of the indicator cards is about 87 per cent. of the theoretical efficiency of the locomotive cycle. As the cut-off is shortened this percentage drops to about 80. In Group 2, with constant cut-off, the cylinder efficiencies are but slightly affected by the change in speed. The theoretical efficiency of the locomotive cycle remains between 15·3 and 15·9 per cent., while the speed is increased from 80 to 200 r.p.m. The actual efficiency shows a somewhat wider range of values with a tendency to show a progressively smaller ratio to the theoretical efficiency.

In considering the variations of the efficiencies it is necessary to take into account the changes in steam pressure and temperature which, as has been observed, accompany the changes in cut-off and speed. In the test of Group 1 with constant speed the shortening of the cut-off, by reducing the amount of steam, lowers the superheat at admission—see Column 6, Table I. This tends to reduce the cylinder efficiency of the locomotive cycle and thus to a certain extent offsets the improvement made by the increase in the ratio of expansion. In the tests of Group 2 with constant cut-off the increasing speed brings an increase in superheat on admission. This would increase the cylinder efficiency of the locomotive cycle, but it is offset by a decrease in the net ratio of expansion. At the higher speeds the steam cannot escape so easily during exhaust, so that the proportion of clearance steam is greater and the net ratio of expansion is consequently less. The higher speeds also decrease the actual cylinder efficiency by increasing the losses by wiredrawing on admission. The balance between these factors having opposite influences accounts for the flat water rate curve in Fig. 6.

Determination of Power by Measurement of Steam Pressures and Temperatures.—It may be of interest to note that, as an alternative to the indicator cards for determining the work developed by the engine it is possible to make use of measurements of the total heat in the steam entering and leaving the cylinders. Table III. is based on the measurements of steam pressure and temperature made simultaneously in the branch pipe and in the exhaust pipe. From these measurements the total heat of the steam at admission and the total heat on exhaust are found. Values for these total heats are tabulated in Columns 3 and 4 respectively. The differences for each test is given in Column 5. Provided the measurement represents accurately the steam conditions during admission and exhaust, the difference between total heat at admission, Column 3, and the total heat at exhaust, Column 4, must represent the heat converted into work together with the heat lost by external conduction and radiation from the cylinders. This loss must be small and therefore the total heat difference should be a close approximation to the heat converted to mechanical work. Values for the amount of heat shown by the indicator cards to be transformed to work are given in Column 6, and it is seen that in tests 7922, 7906 7926, and 7925 there is fair agreement between the values found by the two methods. In tests 7911, 7910, 7912, and 7913 the difference between the total heats of admission and exhaust is less than the heat corresponding to the work shown by the indicator cards. Assuming that the indicator cards are reliable, the discrepancy may be due to too low a value for the total heat on admission or to too high a value for the total heat of the exhaust. The latter is believed to be the more probable explanation. In the four tests in question adiabatic expansion in the locomotive cycle would, as shown in Column 7 of Table II., brings the steam well below the saturation point. The actual expansion line of the indicator cards lies below the adiabatic so that, it is probable that in all of these tests the steam at release was considerably undercooled with condensation on the cylinder walls. It is not unlikely that under such conditions some of the moisture escaped during release and exhaust without being re-evaporated and without affecting the thermometer used to measure the temperature of the exhaust steam. In the case of test 7912, which shows the greatest discrepancy between the total heat difference and the indicated heat, the discrepancy amounts only to 38 B.Th.U., or about 3·6 per cent. of the total heat measured in the exhaust steam. In this test the steam, if expanded adiabatically, would have had 4·5 per cent. of moisture at release. The other tests show less discrepancy between measured and indicated heat, and also less moisture on release after adiabatic expansion.

TABLE III.—*Comparison of Work Converted to Heat as Determined from Indicator Cards and from Heat in Steam Measured at Admission and Exhaust.*

1	2	3	4	5	6
Test No.	Test designation.	Total heat per lb. of steam found from measurement of pressure and temperature.			Heat converted to work per pound of steam as shown by indicator cards, B.Th.U.
		Admission, B.Th.U.	Exhaust, B.Th.U.	Difference, B.Th.U	
7,922	80–90/70	1,332	1,169	163	156
7,906	80–80/50	1,329	1,162	167	168
7,911	80–70/40	1,310	1,160	150	172
7,910	80–60/30	1,300	1,158	142	168
7,912	80–50/20	1,291	1,158	133	171
7,911	80–70/40	1,310	1,160	150	172
7,913	120–70/40	1,330	1,162	168	180
7,926	160–70/40	1,341	1,164	177	175
7,925	200–70/40	1,351	1,182	169	161

Quality of Steam at High-pressure Cut-off.—In the theoretical diagram with adiabatic expansion it is possible to ascertain the quality of the steam at any point in the cycle. It would be interesting if this could be done for the actual expansion cycle, but unfortunately the experimental information is not sufficiently complete. The method described below permits an estimate of the quality of the steam at cut-off in the high-pressure cylinder and provides information as to the amount of heat transferred from steam to cylinder walls in the high-pressure cylinder during admission.

The method is best illustrated by an example, and for this purpose test 7911, 80–70/40, is chosen. In this test cut-off occurs at 69 per cent. of the high-pressure stroke, the piston displacement being 7·20 cubic feet and the clearance volume 1·45 cubic foot, giving a total volume of 8·65 cubic feet of steam at a pressure of 287 lb. per square inch absolute. Compression begins at 15 per cent. of the stroke, giving a volume of 1·57 cubic foot in the cylinder and 1·45 cubic foot in the clearance space, or a total of 3·02 cubic feet of steam to be compressed. Now the steam in the receiver to which the high-pressure cylinder exhausts up to the beginning of compression has an average pressure of 182 lb. per square inch absolute, and an average temperature of 435 deg. Fah., corresponding to a total heat of 1234 B.Th.U. per pound. It is evident that no serious error will be made if it be assumed that when the exhaust port closes and compression begins, the steam in the cylinder and clearance space has the same total heat as the steam in the receiver. With this total heat the pressure at compression of 204 lb. per square inch determines the specific volume as 2·47 cubic feet per pound. The weight of the 3·02 cubic feet of steam to be compressed is therefore 1·22 lb. To this is added during admission 3·33 lb. of cylinder feed, so that at cut-off the weight of steam in clearance and cylinder is 4·55 lb. It has been seen that at this point this weight of steam occupies a volume of 8·65 cubic feet, so that the specific volume at cut-off is 1·90 cubic foot per pound. The pressure at cut-off is 287 lb. per square inch, and for this combination of pressure and specific volume the steam tables show a superheat of 97 deg. Fah. Similar calculations for the other tests give the values shown in Column 4, Table IV.

Heat Transfer to Cylinder Walls.—From the weight and quality of the steam at cut-off the total amount of heat carried by this steam can be found and a further calculation permits a determination of the heat brought into the cylinder. The difference must represent the heat given up to the cylinder walls during admission. Taking test 7911 again, we have at the beginning of compression 1·22 lb. of steam with a total heat of 1234 B.Th.U. per pound. Compression, assuming P V = const., adds 13 B.Th.U. per pound, giving 1·22 lb. at 1247 B.Th.U. per pound, or 1520 B.Th.U. in the clearance volume at the beginning of the stroke. To this is added 3·33 lb. of cylinder feed with a total heat of 1310 B.Th.U. per pound, or 4360 B.Th.U., making a total of 5880 B.Th.U. introduced into the cylinder up to the point of cut-off. At cut-off the pressure of 287 lb. per square inch with 97 deg. of superheat gives a total heat of 1264 B.Th.U. per pound, or a total of 5750 B.Th.U. carried by the 4·55 lb. of steam in cylinder and clearance. The difference between the heat introduced and the heat present in the steam at cut-off—in the present case 130 B.Th.U.—is taken as the heat transferred to the cylinder walls per stroke up to cut-off. As the high-pressure piston makes two strokes per revolution and in test 7911 the speed is 80 r.p.m., the heat transferred to the cylinder walls per minute is 20,800 B.Th.U., and the heat transferred to the cylinder walls per pound of cylinder feed is 39 B.Th.U. From the foregoing it is possible to estimate the part of the pressure loss between branch pipe and admission which is due to the heat transfer to the cylinder walls. If no heat were given to the cylinder walls during admission the total heat carried by the steam at cut-off would be that introduced into the cylinder up to cut-off; that is, 5880 B.Th.U. carried by 4·55 lb. of steam or a total heat of 1292 B.Th.U. per pound. This total heat and the specific volume at cut-off of 1·90 cubic feet per pound would correspond to a pressure of 308 lb. per square inch absolute. The branch pipe pressure in this test was 352 lb. per square inch and the cut-off pressure 287 lb. It appears, therefore, that in test 7911 there was a pressure drop of 65 lb. per square inch from branch pipe to cut-off, and that 44 lb. per square inch of this was due to wiredrawing during admission and 21 lb. per square inch to heat being given up by the steam to the cylinder walls.

TABLE IV.—*Heat Transfer to High-pressure Cylinder Walls During Admission.*

1	2	3	4	5	6	7	8	9	10	11	12
Test No.	Test designation.	At cut-off.		Weight of clearance steam per stroke, lb.	Heat brought into cylinder, B.Th.U. per stroke.			Total heat present in steam at cut-off, B.Th.U.	Heat transferred to high-pressure cylinder walls.		
		Pressure, lb. per sq. in. abs.	Superheat, deg. F.		By clearance steam and compression.	By cylinder feed.	Total.		Per stroke B.Th.U.	Per lb. of steam, B.Th.U.	Per minute, B.Th.U.
7,922	80–90/70	320	167	0·65	821	6,780	7,601	7,500	101	20	16,200
7,906	80–80/50	296	137	0·97	1,215	5,380	6,595	6,460	135	33	21,600
7,911	80–70/40	287	97	1·22	1,520	4,360	5,880	5,750	130	39	20,800
7,910	80–60/30	277	40	1·38	1,710	3,630	5,340	5,130	210	76	33,600
7,912	80–50/20	262	27	1·52	1,880	2,940	4,820	4,630	192	84	30,700
7,911	80–70/40	287	97	1·22	1,520	4,360	5,880	5,750	130	39	20,800
7,913	120–70/40	253	103	1·23	1,570	3,820	5,390	5,200	190	66	45,500
7,926	160–70/40	233	143	1·12	1,495	3,380	4,875	4,690	185	74	59,200
7,925	200–70/40	237	133	1·21	1,615	3,380	4,995	4,750	245	97	98,000

* Marks and Davis's "Steam Tables."

The results of similar calculations for the other seven tests are shown in Table V.

TABLE V.—*Pressure Drop During Admission to High-pressure Cylinders.*

1	2	3	4	5	6	7	8
		Pressures, lb. per sq. in. absolute.			Pressure, drop, lb per sq. in.		
Test No.	Test desig.	In br'nch pipe.	Computed for cut-off, if no heat tr'nsfer.	At cut-off from indicator cards.	Due to wire-drawing.	Due to heat transfer.	Total, branch pipe to cut-off.
7,922	80–90/70	347	336	320	11	16	27
7,906	80–80/50	335	315	296	20	19	39
7,911	80–70/40	352	308	287	44	21	65
7,910	80–60/30	354	315	277	39	38	77
7,912	80–50/20	354	297	262	57	35	92
7,911	80–70/40	352	308	287	44	21	65
7,913	120–70/40	348	288	253	60	35	95
7,926	160–70/40	342	263	233	79	30	109
7,925	200–70/40	336	278	237	58	41	99

The information obtained by the methods described is plotted in Figs. 10, 11, and 12. Fig. 10 shows the steam pressures measured in boiler, branch pipe, and at cut-off, and the estimated pressure at cut-off if there were no transfer of heat to the cylinder walls during admission. A line E E is also added to show the rate of flow of steam to the cylinders. In the graph the boiler pressures,

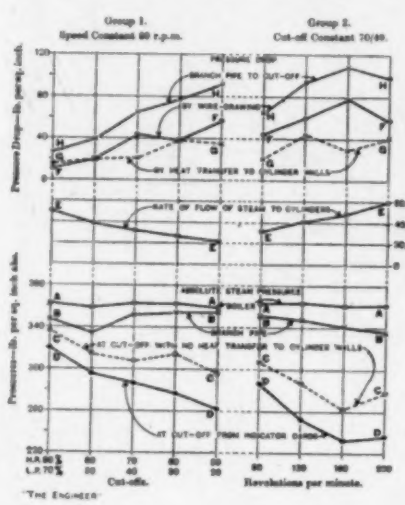


FIG. 10.

line A A, are very nearly the same for all tests. With constant speed the difference between the branch pipe pressure, line B B, and boiler pressure, line A A, decreases as the cut-off is shortened. This is because the weight of steam flowing to the cylinders falls off. With constant cut-off, on the other hand, the rate of steam flow increases with the speed and the pressure drop between boiler and branch pipe increases correspondingly. The cut-off pressures taken from the indicator cards are plotted as

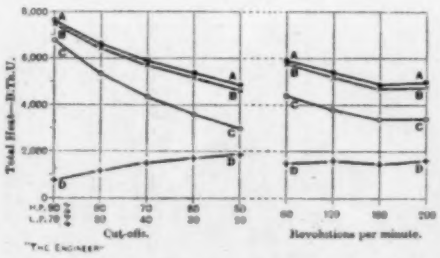


FIG. 11.—*Total Heat Carried by Steam per Stroke in High-pressure Cylinder.*

AA—Total heat admitted in H.P. cylinder.
BB—Heat present in steam at cut-off in H.P. cylinder.
CC—Heat introduced by cylinder feed.
DD—Heat introduced by clearance steam and compression.

Group 1. Speed constant, 80 r.p.m. Group 2. Cut-off constant, 70/40.

the line D D, and the pressure drops from branch pipe to cut-off are plotted as the line H H. With constant speed the drop from branch pipe to cut-off increases uniformly as the cut-off is shortened. This drop is due to two causes, the wiredrawing of the steam through the ports and valve and the transfer of heat from the steam to the cylinder walls. Separation of the effects of these two sources of pressure loss determined by the method explained above is shown by the line C C, which shows the pressure which should be present at cut-off if there were no transfer of heat to the cylinder walls. The differences between lines B B and C C are plotted as the line F F, pressure drop due to wiredrawing, and the difference between lines C C and D D is plotted as line G G, the pressure drop by heat transfer to cylinder walls. The points are not numerous enough to establish tendencies beyond question, but it appears justifiable to draw the following inferences. At a constant speed of 80 r.p.m. the pressure drop between branch pipe and cut-off is divided approximately equally between wiredrawing and heat transfer for cut-offs from 90/70 to 50/20 per cent., the drop from each cause rising from about 15 lb. per square inch at a cut-off of 90/70 per cent. to about 45 lb. per square inch at a cut-off of 50/20 per cent. At a constant cut-off of 70/40 per cent., with speeds varying from 80 to 200 r.p.m., the indications are less certain. The pressure loss from wiredrawing rises uniformly from 44 lb. per square inch at 80 r.p.m. to 70 lb. per square inch at 160 r.p.m., and then shows a drop to 58 lb. per square inch at 200 r.p.m. The latter figure may be due to the cut-off pressure in this test being higher than is normal. There does not appear to be any reason for expecting that, with the speed increasing from 160 to 200 r.p.m., and with the steam to the cylinders increasing from 48,000 lb. to 60,000 lb. per hour, the cut-off pressure should increase from 233 lb. to 237 lb. per square inch, and that the pressure loss from wiredrawing should fall from 79 lb. to 58 lb. per square inch. A reasonable interpretation of the figures is that at a cut-off of 70/40 per cent. the pressure loss by wiredrawing increases with increasing speed from about 45 lb. per square inch at 80 r.p.m. to about 80 lb. or 90 lb. per square inch at 200 r.p.m. The figures for pressure loss by heat transfer are also somewhat erratic. The loss at speeds of 120, 160, and 200 r.p.m. is respectively 35 lb., 30 lb., and 41 lb. per square inch and 21 lb. per square inch at 80 r.p.m. The last figure is shown by the constant-speed tests to be probably too low, so that it appears that at a cut-off of 70/40 per cent. the pressure loss from heat transfer may be expected to be between 30 lb. and 40 lb. per square inch for speeds from 80 to 200 r.p.m., approaching the low value for the lower speeds and the higher value for the higher speeds. Fig. 11 shows the total amount of heat introduced into the high-pressure cylinder per stroke, and how it is divided between cylinder feed and clearance steam. Fig. 12 gives the same information, but as heat per

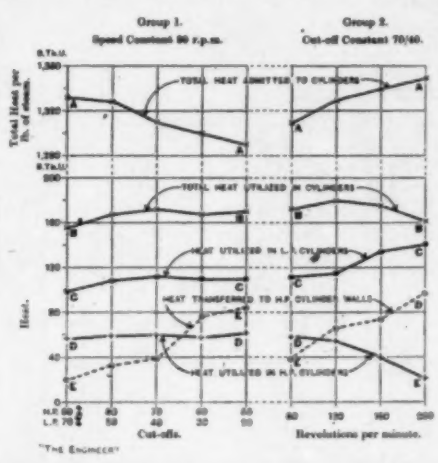


FIG. 12.—*Heat Distribution per lb. of Cylinder Feed in Cylinders.*

pound of steam instead of in total amounts. In this figure the line A shows the total heat per pound of steam at branch pipe pressure and temperature. At constant speed shortening the cut-off reduces, as has already been noted, the superheat and therefore the total heat, while with constant cut-off an increase in speed increases the superheat and the total heat per pound of steam. The lines B B, C C, and D D show the heat utilised by the cylinder as determined by the indicator cards. The line B B shows the total amount of heat converted to mechanical work in high and low-pressure cylinders, while the lines C C and D D show how the utilisation of this heat is distributed between the low and high-pressure cylinders respectively. At the constant speed of 80 r.p.m. and between cut-offs of 80/50 and 50/20 per cent. the work developed per pound of steam is very nearly constant at 60 B.Th.U. in the single high-pressure cylinder and 170 B.Th.U. in the two low-pressure cylinders. At the long cut-off of 90/70 per cent. the work per pound of steam is slightly less in both sets of cylinders. These figures show that at 80 r.p.m. the work developed is divided approximately evenly between the three cylinders, the single high-pressure producing about 35 per cent. and the two low-pressure cylinders about 65 per cent. of the total work. The distribution is seen to change considerably as the speed is increased. At 120 r.p.m., or 22·5 miles per hour, the high-pressure cylinder contributes 30 per cent. of the work which still represents a fairly uniform distribution between the three cylinders but this percentage drops rapidly as the speed is further increased, until at 200 r.p.m. the work done by the high-pressure cylinder is only about 13 per cent. of the total. This transfer of work from the high to the low-pressure cylinders at high speeds is not a disadvantage. Locomotive No. 60,000 was designed as a freight locomotive, and as such will do its heaviest work at speeds less than 25 miles an hour. In this speed range the distribution of power between the three cylinders is reasonably uniform.

The figures for power distribution have all been obtained from the horse-power shown by the indicator cards, and are given here in terms of B.Th.U. so that they may be compared with the heat transfer to the high-pressure cylinder walls during admission. This heat transfer is shown in Fig. 11 by the broken line E E. At a constant speed of 80 r.p.m. each pound of cylinder feed steam gives up to the cylinder walls during admission—that is, up to the point of cut-off—20 B.Th.U. at a cut-off of 90/70 per cent. As the cut-off is shortened the heat given up to the walls increases steadily until at a cut-off of 50/20 per cent. it is 84 B.Th.U. This is, of course, accounted for by the greater temperature range in the cylinder with the shorter cut-offs. The heat transfer is also greatly increased by an increase in speed. At a constant cut-off of 70/40 per cent. the heat given to the high-pressure cylinder walls rises from 39 B.Th.U. per pound of steam at 80 r.p.m. to 97 B.Th.U. at 200 r.p.m. These figures give the heat transferred per pound of steam entering the cylinder. Now, the weight of steam entering per minute increases with the speed and when this is taken into account the heat transferred per minute at a cut-off of 70/40 per cent. increases from 20,800 B.Th.U. at 80 r.p.m. to 98,000 B.Th.U. at 200 r.p.m. The expansion has been seen to be but little affected by the speed, and therefore the temperature range is practically constant. The only explanation for this large increase in rate of heat transfer with increasing speed seems to be that the more rapid flow of steam through the steam passages and ports increases the rate of heat transmission between steam and cylinder metal.

It would be interesting to follow the steam through its expansion in the high-pressure cylinder and through the receiver and the low-pressure cylinders, and to be able to determine the heat exchange between steam and cylinders and then again between cylinders and steam in the various stages of the power development. Sufficient data are not, however, available to permit the study being carried further than the high-pressure cut-off.

Actual versus Theoretical Cylinder Efficiency.—Information as to the difference between the work shown by the actual indicator cards and the work which would be developed by the theoretical diagrams of the locomotive cycle is given in Columns 11 to 13, Table II., and in Fig. 8. This difference represents the amount by which the work actually developed falls short of the maximum work theoretically obtainable from perfect operation with the steam quality, the final exhaust pressure and the ratio of expansion which were observed in the tests. The figures in Column 13, Table II., give the actual work as a percentage of the theoretical, but the deficiency is not separated into its component parts. To effect such separation the indicator diagrams and the locomotive cycle diagrams must be plotted accurately to the same scale. The values for heat converted to work and for cylinder efficiency, Columns 9 to 13, Table II., are computed both for indicator cards and for locomotive cycle diagrams from average values covering both ends of cylinders throughout each test. The diagrams in Fig. 8, while showing generally the relation of the adiabatic locomotive cycle to the actual cards, do not give such an accurate comparison as the tabulated figures, because the scale is not quite the same for both sets of diagrams. The actual cards are derived from a single set of head-end cards, while the theoretical diagrams use average values from all cards taken during each test. To give a more accurate comparison Fig. 13

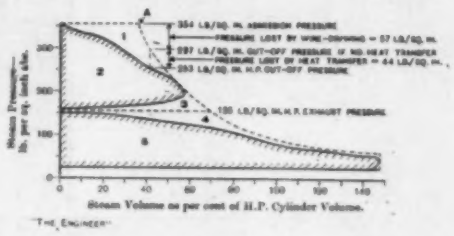


FIG. 13.—*Test* 7912, 80–50/20.

Indicator diagrams compared with adiabatic loco.-cycle diagram.

Area.	Work per lb. of steam.		Per cent.	Useful work.
1. Loss during H.P. admission	17·0 B.Th.U.	..	8·2	—
2. Work done in H.P. cylinder	60·8	,, ..	29·2	29·2
3. Loss during H.P. exhaust	8·7	,, ..	4·2	—
4. Loss during L.P. admission	11·3	,, ..	5·4	—
5. Work done in L.P. cylinders	110·2	,, ..	53·0	53·0
Total work of loco.-cycle diagram	208·0	,, ..	100·0	82·2

Speed 80 r.p.m.
Average cylinder volume for each high and low-pressure cylinder 10·44 cu. ft.
Average clearance volume 1·45 cu. ft.
Receiver volume 21·9 cu. ft.

has been drawn. The shaded area represents the indicated work done during the test, and is obtained by averaging all the indicator cards taken during test 7912, 80–50/20.

The broken-line diagram is obtained by plotting the point A to represent the volume of the cylinder feed at branch pipe pressure and temperature and drawing an adiabatic expansion line terminating at the volume of 15·5 cubic feet, to which the steam was expanded in the original diagram. This comprises the locomotive cycle, which has been already computed for this test to give 208 B.Th.U. per pound of steam. The indicator cards for this test average 522 horse-power in the high-pressure and 949 horse-power in the low-pressure cylinders, a total of 1471 horse-power. With a cylinder feed of 21,882 lb. per hour at 80 r.p.m. this represents 60·8 B.Th.U. of work developed per pound of steam in the high-pressure and 110·2 B.Th.U. per pound in the low-pressure cylinders, a total of 171 B.Th.U. per pound of steam. This is 82·3 per cent. of the work theoretically obtainable in the locomotive cycle diagram. The remaining 17·8 per cent. is made up of the three areas marked 1, 3, and 4 in Fig. 12. The area 1 represents the work lost during admission to the high-pressure cylinder by reason of wiredrawing through the ports and by transfer of heat to the cylinder walls. This loss is found, by measuring the area 1, to amount to 17·0 B.Th.U. per pound of steam, which is 8·2 per cent. of the area of the locomotive cycle diagram. The computations already described show that with no transfer of heat the cut-off pressure would be 297 lb. per square inch, a drop of 57 lb. from the admission pressure of 354 lb. per square inch. The cut-off pressure actually measured is 253 lb., a further drop of 44 lb. per square inch. Taking 155 lb. per square inch as the least back pressure in the high-pressure cylinder, the area 3, equivalent to 8·7 B.Th.U. per pound of steam, or 4·2 per cent. of the locomotive cycle diagram, represents the loss during the high-pressure exhaust. Also the area 4 equivalent to 11·3 B.Th.U., or 5·4 per cent. of the total work, represents the loss during admission to the low-pressure cylinders.

Conclusion.—This completes the survey of the cylinder action of locomotive No. 60,000. It has been shown—Fig. 1—that with a steam pressure of 350 lb. per square inch above atmosphere the highest possible theoretical cylinder efficiency is about 16·5 per cent., and that about five expansions are required for this. The best test, No. 7913, 120–70/40, shows—Table II.—an actual cylinder efficiency of 13·6 per cent., which is over 82 per cent. of the highest possible. This is thought to be an extremely satisfactory performance. Test 7913 was run at 120 r.p.m.

and 40 per cent. cut-off in the high-pressure cylinder. Changes of speed and cut-off from this optimum combination decrease the cylinder efficiency. Such changes, however, affect a number of factors which influence the cylinder efficiency. In some cases the change tends to increase and in others to decrease the efficiency and the result of the interplay of these factors is to keep the cylinder efficiency comparatively uniform through the range of speeds and cut-off in which the locomotive operates.

The basic experimental data on which all calculations and conclusions are based are those reported by the Pennsylvania Railroad observers during the tests made at Altoona. The author is indebted to Mr. C. D. Barrett, Assistant Engineer of Tests, Pennsylvania Railroad, for suggestions and assistance in the preparation of the paper.

The Quadruple-Screw Motor Liner Bermuda.

No. II. (*Conclusion*).*

Machinery Arrangement.

The main and auxiliary machinery of the motor liner Bermuda is accommodated in two engine-rooms, and a section through them is reproduced in Fig. 4. In the after room there are the four Doxford propelling engines, together with certain smaller auxiliaries, while in the forward room are arranged the oil engine driven generator sets, the switchboard, along with various pumps and the boilers. As will be seen from our illustration, the lubricating oil storage and drain tanks are arranged in the double bottom of the vessel. The supply tanks for both fuel and lubricating oil are accommodated in the main engine-room hatches, those for the purified lubricating oil being built into the ship at the forward end of the engine-room. In our previous article, we drew attention to the neat arrangement of the main engine controls at the forward end of the engines. The general lay-out of the exhaust pipes and scavenge air pipes is indicated in Fig. 4, those for the main engines being carried up to the after engine-room hatch, while the hatch in the forward engine-room is reserved for the auxiliary engine exhausts and scavenge air pipes, and the boiler uptakes. In the main room each pair of engines is served by a travelling crane, and about half an hour is required, we understand, to remove the pistons from a given cylinder. Special ventilating arrangements have been made, and air is supplied to the engine-room by eight motor-driven Sirocco fans, situated on "A" deck and the top of the casing.

* No. I. appeared December 23rd.

Auxiliary Generator and Boiler Plant.

Electric current for the lighting of the ship and the power requirements of both deck and engine-room auxiliaries is provided by four Fiat single-acting three-cylinder engines, operating on the two-stroke cycle. The cylinders have a diameter of 15¾in., with a stroke of nearly 19¾in., and each of the four units is designed for a normal output of 450 B.H.P. at 250 r.p.m. This output is obtained with a brake mean pressure of 61 lb. per square inch, and a piston speed of 785ft. per minute. The engines are of the cross-head type, with the scavenge air pumps and the injection air compressors arranged at opposite ends of the bed-plate.

Each engine is coupled direct to a 300-kW, 220-volt generator supplied by the General Electric Company, Ltd. The normal output of the four generators is rated at 1200 kW, but in case of emergency it can, we understand, be safely raised to 1320 kW. Under normal operating conditions, a load of 850 kW at sea is expected, which will allow one set to serve as a stand-by unit. Engraving, Fig. 5, shows a view of the four generators; while Fig. 6 illustrates the twenty-three-panel main switchboard and switchboard gallery. The length of the switchboard is 54ft. Provision is made to control all circuits by a system of specially planned feeders. A storage battery is also provided to take care of sudden emergency demands and to maintain a skeleton lighting service, while the emergency generators are being started up. These comprise two 36-kW dynamos, which are driven by Weir-Sulzer oil engines, and together with the emergency switchboard are situated on a deck well above the water line.

To the right of Fig. 4 will be seen one of the two heating boilers, which are of the Meredith vertical multi-tubular type, supplied by Riley Brothers (Boilermakers), Ltd., of Stockton-on-Tees. Each boiler is 17ft. high, with a diameter of 8ft. 6in. It has 1000 square feet of heating surface, and is designed to evaporate 6000 lb. of water per hour. The boilers are oil fired, and are fitted with Todd burners. They are constructed for a working pressure of 125 lb. per square inch. Further auxiliaries for the steam plant include two Weir feed pumps and two 40-ton evaporators of the Quiggin's type, together with a 450 square feet auxiliary condenser.

Pumping and Compressor Equipment.

The pumps for the essential services are all motor driven and are either of the centrifugal or the two-throw reciprocating type. For the sea water cooling supply and the fresh water for the pistons, and for the lubricating circuits, there are three pumps provided, any two of which will perform the required duty.

The sea water circulating system is connected with three 8in. upright pumps, which were supplied by Drysdale and Co., Ltd. They are each driven by a 36 B.H.P. variable-speed motor, and are designed for an output of 300 tons per hour. The fresh water, jacket cooling, and piston cooling services are maintained by three 8in. Centrex pumps, supplied by the same makers, each of which delivers 170 tons of water per hour to the jackets at 15 lb. to 20 lb. pressure, and 80 tons to the pistons at the higher pressure of 40 lb. Incidentally, it may be remarked that the inlet water temperature to the pistons and cylinder jackets is maintained at 140 deg. Fah., while the outlet temperature is about 155 deg. Attached to the cooling water circuits referred to are Serck coolers, which are also used on the lubricating systems. This type of cooler is made without ferrules, the tubes being fixed into the tube plates by a patented process.

For the lubrication of the engines there are three rotary pumps of the Feuerheerd type, supplied by Stothert and Pitt, Ltd. Each pump is driven through gearing by a 13 B.H.P. variable-speed vertical spindle motor, and is rated at 54 to 66 tons of oil per hour,

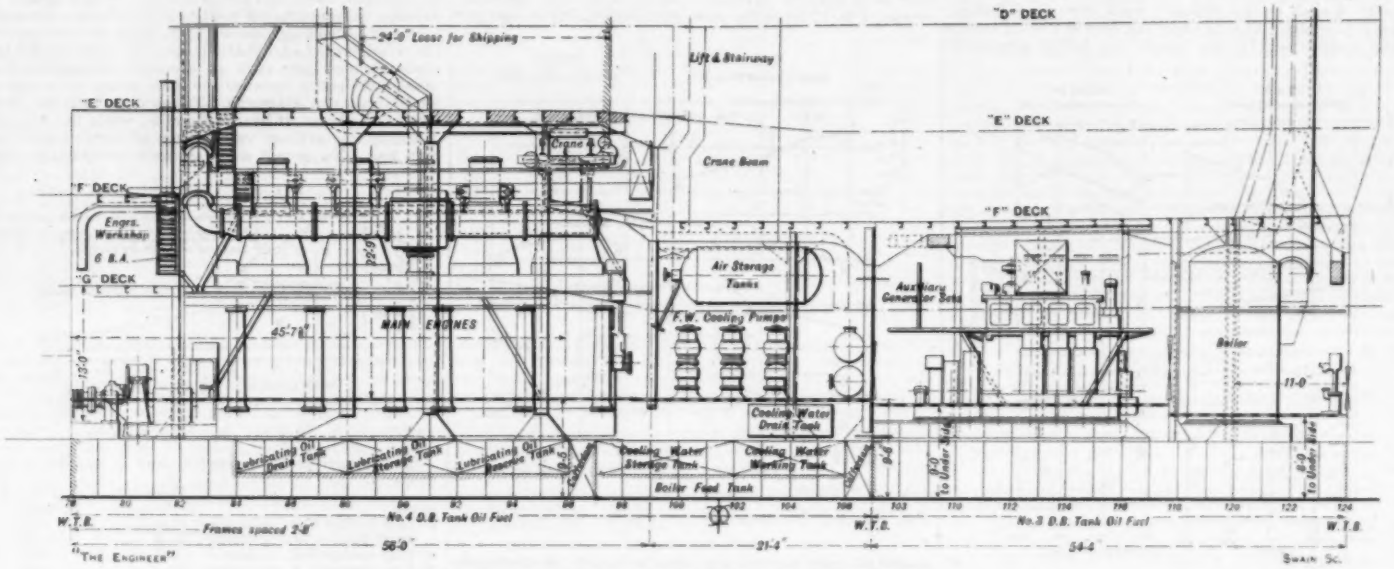


FIG. 4—LONGITUDINAL SECTION THROUGH ENGINE ROOMS

FIG. 5—OIL ENGINE-DRIVEN ELECTRIC GENERATOR

FIG. 6—MAIN SWITCHBOARD

delivered against a working pressure of 30 lb. per square inch. In normal service two pumps are used, and one pump is a spare unit.

The three motor-driven compressors for supplying the starting air were built by Reavell and Co., Ltd. They are of the three-stage vertical enclosed pattern, with forced lubrication, and each compressor is designed to deliver 240 cubic feet of free air per minute when running at 350 r.p.m. Each machine is driven by its own 105 B.H.P. motor, and with the motor it forms a compact unit on a combined bed-plate. Volume control is fitted, and the starting air pressure is 600 lb. per square inch. Messrs. Reavell also supplied a 15 cubic foot emergency air compressor, which is steam driven and delivers oil at a pressure of 1000 lb. per square inch.

Other interesting auxiliary units are the reserve fuel pumps, which are duplicates of the fuel pumps on the main engines, but are driven by a 20 B.H.P. motor, see Fig. 9, and are arranged at the forward end of the engine-room, one port and one starboard. Normally, two rams of each pump are connected to the fuel system of one of the four main engines, but provision is also made for the port pump to supply fuel to the two port engines, and the starboard pump to the two starboard engines. The pumps referred to are used for priming and testing the oil fuel system before starting.

All the pumps for the bilge, ballast, general service and fire duties are—if the Drysdale S.O.S. Centrex emergency bilge pump be excepted—of the two-throw double-acting type, and were built by Dawson and Downie, Ltd., of Clydebank. The barrels are 9in. in diameter, with a stroke of 8in., and most of the parts are interchangeable, so that the number of spares carried is reduced. Each pump is directly coupled to a 30 B.H.P. motor, mounted alongside it on a combination bed-plate.

Two pumps of similar design are employed for the domestic fresh-water service.

Particular attention has been given to the problem of the separation of oily bilge water and the cleaning of both fuel and lubricating oils, and a special scheme has been worked out for this purpose by Mr. E. W. Harvey, the owners' chief superintendent engineer. Altogether there are six reserve tanks, which are set apart for treatment of oil, and they are served by three oil transfer pumps of the Weir type. There are two 75-ton oil pumps and one pump for dirty oil with a capacity of about 20 tons per hour. These pumps are cross connected and are therefore interchangeable. Three of the tanks are provided for fuel oil, two for lubricating oil, and one serves as a standby. Purification is effected in a battery of six Sharples centrifugal oil separators of the latest enclosed type.

The oily bilge water separator is of the Harvey-Holford pattern and is designed to deal with all the bilge water and the tank drainage, so that any contamination of the sea water by oil is prevented. It is of a vertical cylindrical form and is designed to deal with 100 tons of oil water per hour. The degree of separation is guaranteed to be so effective that the trace of oil left in the effluent water will not exceed 0·0002 of the whole.

Some Deck Auxiliaries.

The two illustrations Figs. 7 and 8 show the windlass and capstan and a group of cargo winches, all of which were supplied by Clarke, Chapman and Co., Ltd. The windlass is designed to deal with 3in. cable and is electrically operated, being driven by a 125 B.H.P. motor through worm reduction gearing. There are two cable lifters and two fast-speed warping ends. The controls are arranged at the after side of the windlass, which is designed to deal with a normal pull of 25½ tons at 25ft. per minute or an overload pull of 34 tons. When dealing with slack cable the speed is about 50ft. per minute. The pull off the warping ends is 6½ tons at 120ft. per minute, and when hauling slack rope about 240ft. per minute can be dealt with. There are three capstans, one in the bows forward of the windlass—see Fig. 7—and one at each side of the mooring deck aft. They are equipped with change speed gear in the base of the capstan heads and are designed to haul 13 tons at 45ft. per minute, 3 tons at 150ft. per minute, and slack rope at 250ft. per minute. They are driven from beneath by 65 B.H.P. motors, and contactor gear similar to that employed on the winches is fitted. The main controls are arranged above deck at the side of the capstan barrels. In order to deal with the stockless stream anchor and its chain cable, which will be more particularly employed when cruising, a lead is provided through a stern hawse pipe and chain compressors to the port capstan, which is equipped with a cable lifter and a chain pipe leading to a chain locker below. The cable lifter is furnished with an engaging gear, a powerful automatic brake magnetically released, and a slipping clutch so that the anchor can be housed without shock to the gear.

The cargo-handling gear includes eight electric winches, two of each serving the four cargo hatchways. They are designed for lifts of 5 tons at 120ft., 2 tons at 150ft., and 1 ton at 300ft. per minute; 48 B.H.P. motors of the totally enclosed type are fitted, and drive the winch through gearing working in an oil bath. As shown by Fig. 8, the four winches adjacent to the foremast are provided with barrel clutches so that two winches can be coupled together when derricking or for dealing with specially heavy lifts. A special switch is provided for use when working in this manner so that both winch controls can be operated from a single master controller.

The steering gear, to which brief reference was made in our first article, was supplied by John Hastie and Co., Ltd., of Greenock, and is of the Hele-Shaw Martineau type. The pump controls are operated from the bridge by telemotor gear of MacTaggart Scott and Co.'s latest type.

In conclusion, it may be stated that all the electric motors and electrical apparatus throughout the ship, including the lighting equipment, was manufactured and supplied by the General Electric Company, Ltd., of Witton and London, while the whole of the wiring and cables was installed by the Sunderland Forge and Engineering Company, Ltd., of Belfast and Sunderland.

Trial Results.

The Bermuda left the yard of Workman, Clark and Co., Ltd., on Wednesday, December 14th, and proceeded to the Clyde, where progressive trials were run over the measured mile at Skelmorlie. Although the designed speed of the ship is 18 knots, it was shown that 19 knots was attained with a total expenditure of 14,500 S.H.P.

At the conclusion of the speed trials the vessel proceeded down channel, and a run of twenty-four hours' duration at the service power of 11,250 S.H.P. was made. It was followed by a run of twelve hours at 13,500 S.H.P. We understand that all these trials were carried out successfully and to the entire satisfaction of the owners of the ship and their representatives.

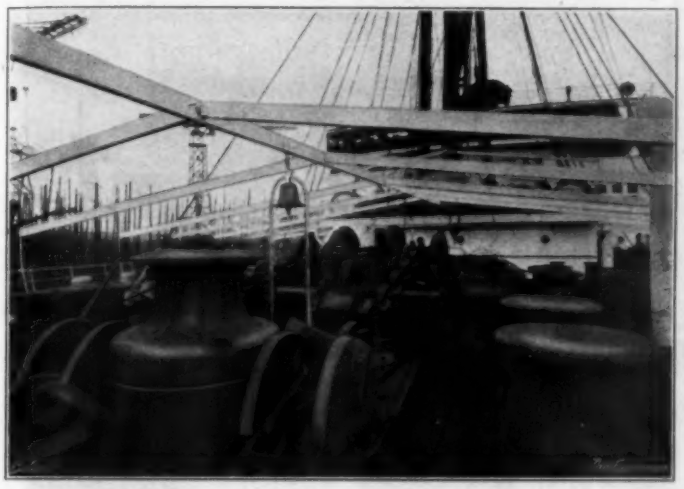


FIG. 7—WINDLASS AND CAPSTAN

FIG. 8—CARGO WINCHES

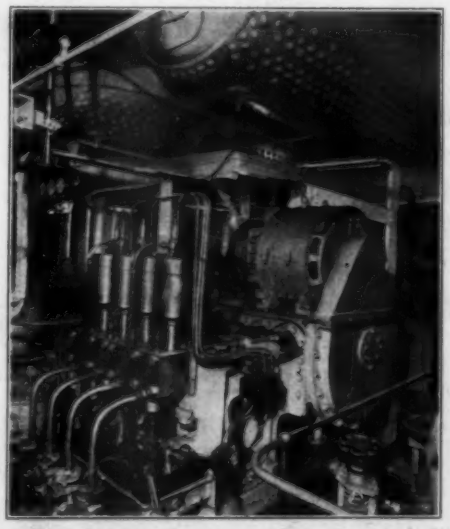


FIG. 9—RESERVE FUEL PUMP

SIXTY YEARS AGO.

From a leading article in our issue of December 27th, 1867, we gather that sixty years ago criticism of the ways and doings of the Admiralty were rife in many quarters. The chief parliamentary critic was Mr. Seely, the Member for Lincoln. We stoutly supported his attack. "One of the most inefficient and illogically constituted bodies ever known" was the phrase we used to describe the Board of Admiralty. The Board was, we said, constituted of naval officers "possibly more or less fit to fight an old wooden sailing ship" and treated engineers in the same way as that in which it treated doctors. Describing the position of doctors in the Fleet, we said that until quite recently there had been no such thing as a modern medicine chest in the service, that the use of quinine was ignored in the Admiralty pharmacopœia, and that the surgeons, instructed according to modern methods, did not even know the use of many of the obsolete medicines of the official medicine chests of the Navy. In the opinion of the critics, the control and management of the dockyards were inefficient, because of the constitution of the Board of Admiralty, the defective organisation of the subordinate departments and the want of clear and well-defined responsibility. On the strength, it was alleged, of official documents, they stated that the cost of repairs to certain ships had exceeded their original cost of construction, and that since 1842 the money expended on the purchase of anchors exceeded the market value by £170,000. These were but two of the specific charges brought against the Admiralty. In considering them to-day we ought perhaps to remind ourselves that the time was a period of transition in naval construction. Previously, in the days of wooden sailing ships, the dockyards had been solely charged with the duty of building vessels for the Navy. With the advent of iron steamers they had to turn to outside private firms, which had acquired considerable experience in the building of iron mercantile vessels before the Admiralty took up the iron war vessel. The private contractors, in spite of their experience, greatly underestimated the cost and difficulty of building iron warships. It is therefore not surprising that the dockyards brought up for centuries, on the traditions of wooden warship building, blundered badly, and laid themselves open to severe criticism when they attempted to pass to the construction of iron vessels. That the time was truly a period of transition in warship construction is made abundantly evident by a paragraph in the same issue, announcing the launch at Devonport Dockyard of two gunboats, the Fly and the Flirt. These vessels, built to the design of Mr. E. J. Reed, the Constructor of the Navy, had frameworks of angle iron with iron intercostals and longitudinal stringers. This framework was planked with two thicknesses of teak, the inner skin 3in. thick and the outer 2in.

Two petrol tanks, which will be the largest in South Africa, are to be constructed in Durban by the Shell Oil Company, the local agents of whom are Cotts and Co. The tanks will have a capacity of 2,500,000 gallons, or 5400 tons, each.

PNEUMATICALLY-CONTROLLED WHEEL LATHE

NOBLE AND LUND, LTD., NEWCASTLE-ON-TYNE, AND ALFRED HERBERT, LTD., COVENTRY, ENGINEERS

(*For description see opposite page*)

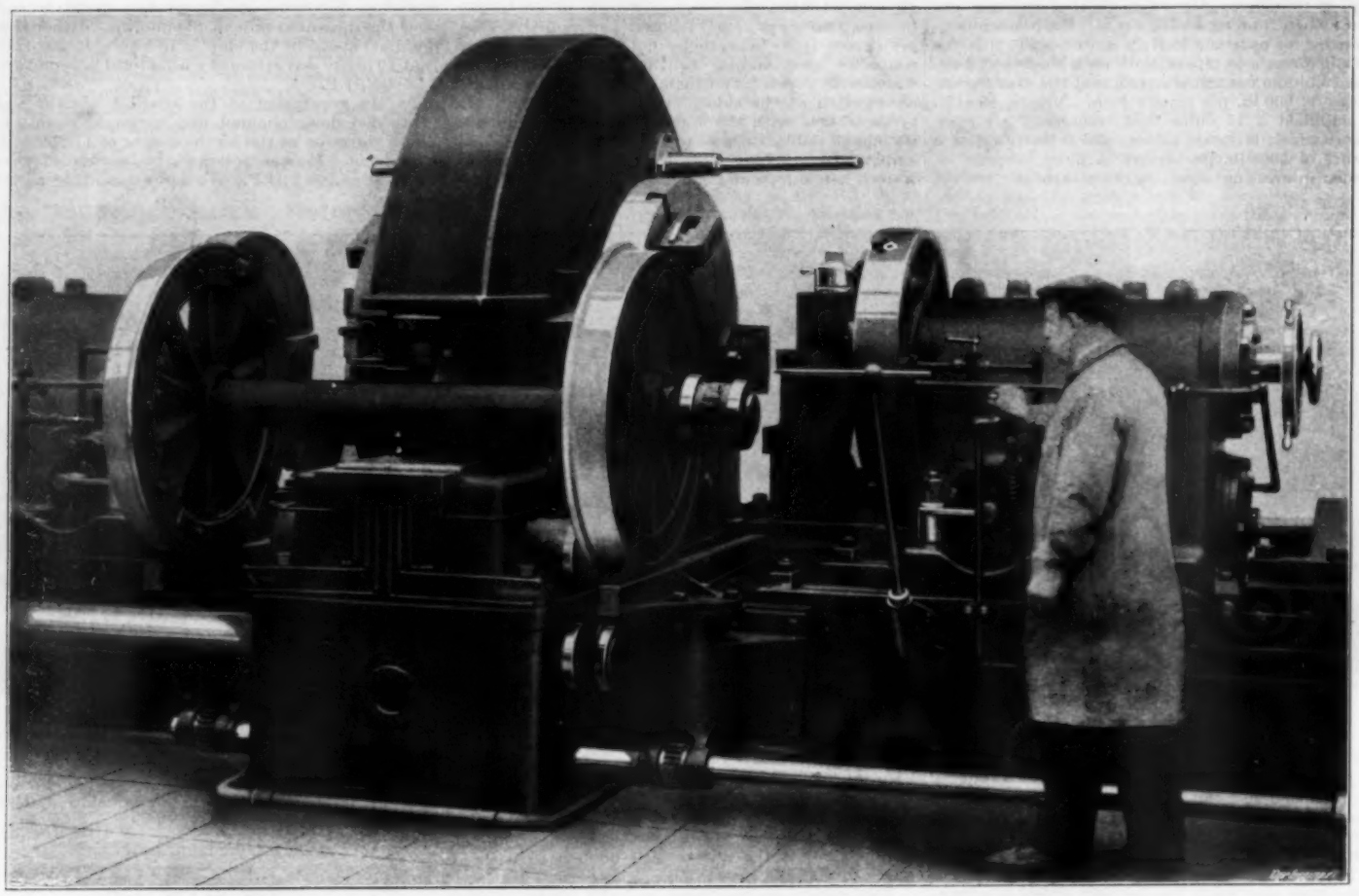


FIG. 1—LOADING A PAIR OF WHEELS INTO THE LATHE

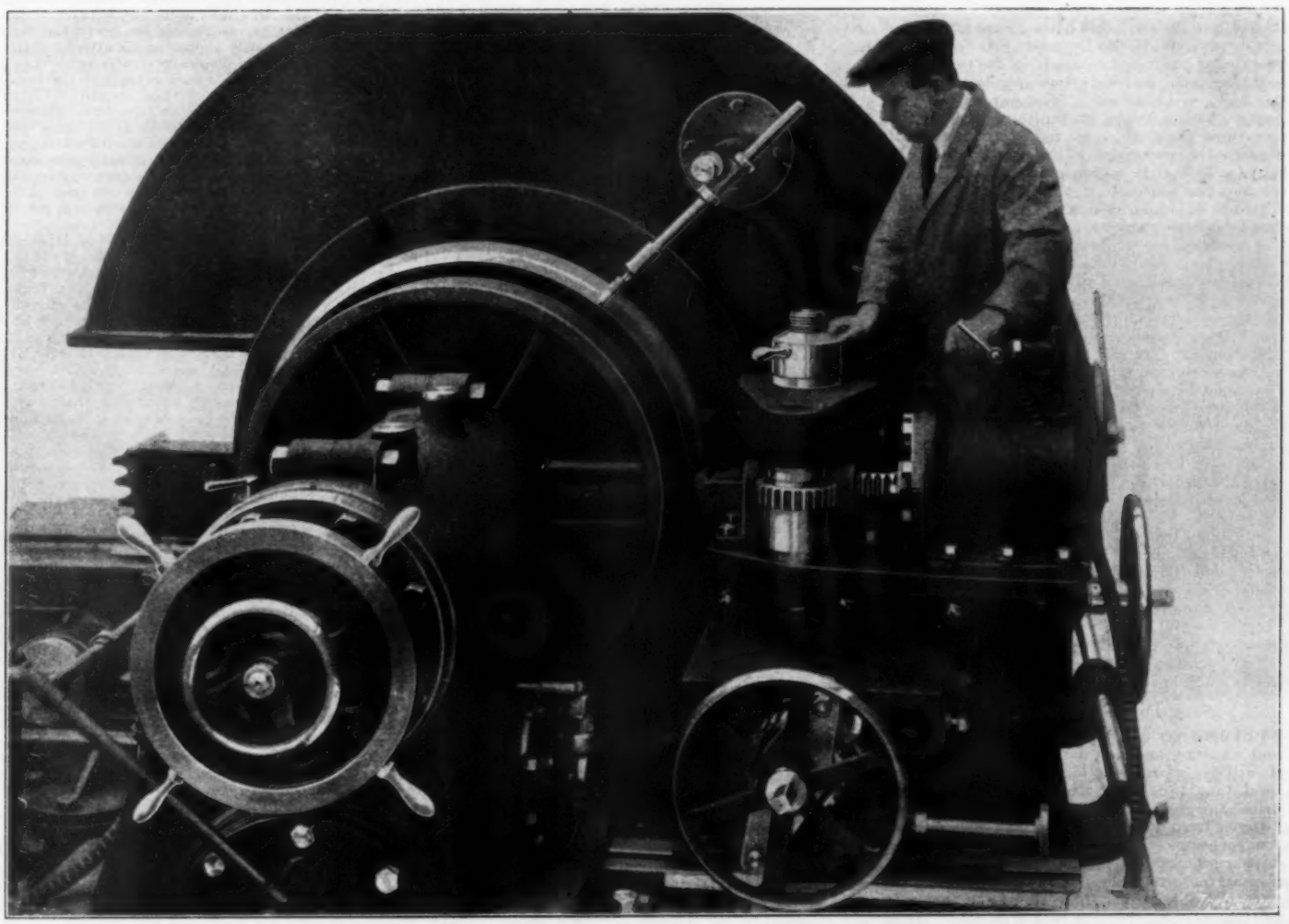


FIG. 2—TOOL SLIDE WITH PNEUMATIC TOOL CLAMP

A Pneumatically-Controlled, Centrally Driven Wheel Lathe.

THE machine which we are about to describe is a lathe intended to deal quickly and accurately with any type of railway carriage or wagon wheel of from 30in. to 48in. in diameter, and can be produced to suit wheels of the standard or 5ft. 6in. gauge as required—but not both in the one machine. It was made by Noble and Lund, Ltd., of Newcastle-on-Tyne, and was designed by that firm in collaboration with Alfred Herbert, Ltd., of Coventry. It is capable, we are informed, of rough turning and profiling the hardest brake-hardened or sorbitic tires without vibration under the maximum feeds. In addition, tests have proved that the rigidity of the machine is such that on the same hard tires very light cuts with coarse feeds can be taken.

The distinguishing features of the lathe are its central driving system and its pneumatic control equipment. A front view of the machine is given in Fig. 3, and in Fig. 4 we reproduce a view taken from the rear. Fig. 6—and also Fig. 1, page 736—will help to make clear the details of the central driving arrangement. It will be gathered that the wheels, mounted on their axle, are driven by means of a large gear wheel situated midway between the wheels and parallel with them. In order that the wheels may be brought to the centre of the gear wheel, that wheel is formed with a radial gap for the passage of the axle inwards to the centre line of the lathe. This gap, when the wheels are in position, is not filled in with a loose piece, a practice which the designers consider undesirable from the point of view of complication and possibility of breakdown. The difficulty of driving the gear wheel with a gap existing in its ring of teeth is overcome by causing it to engage with not one, but two driving pinions so disposed that at least one must always be clear of the gap, while for the bigger part of each revolution both are in driving engagement. The gear wheel is of steel and is rigidly bolted to a hollow cast iron spindle of large diameter. This spindle is supported in large bearings on each side of the gear wheel and at each end is provided with a face-plate. The spindle, the two bearings, and the two face-plates are, like the gear wheel, formed with radial gaps for the passage inwards of the axle. The dimensions of the spindle and the gap in it are such that when the gap is pointing vertically downwards the gear wheel, the spindle, and the two face-plates remain centrally supported on the unbroken lower portions of the two bearings. No doubt in such a position the weight of the gear wheel spindle and face-plates throws extra stress on to the metal of the spindle near the edges of the gap and will tend to pinch the gap and reduce its width. The parts are, however, sufficiently strong to withstand such extra stress, and in any event that stress will only arise, or will only arise fully, when the machine is run unloaded. When it is loaded the weight of the work—the two wheels and their axle—is not added to the weight transmitted by the central driving members to their bearings. The manner of supporting the work is such as to reduce the loading on the driving member bearings.

It will be gathered from Fig. 6 that before the wheels are loaded into the machine split taper bushes are strapped round the axle journal seats. When the wheels have been centred relatively to the face-plates the tail stocks of the machine are moved along the bed towards one another. Each tail stock is provided with a freely revolving face-plate and spindle, and inside each spindle there is a second spindle which can be advanced independently by means of a hand wheel at the end of the tail stock. The internal spindles, when they are advanced, embrace and grip the split bushes on the axle ends and by so doing centralise and support the work,

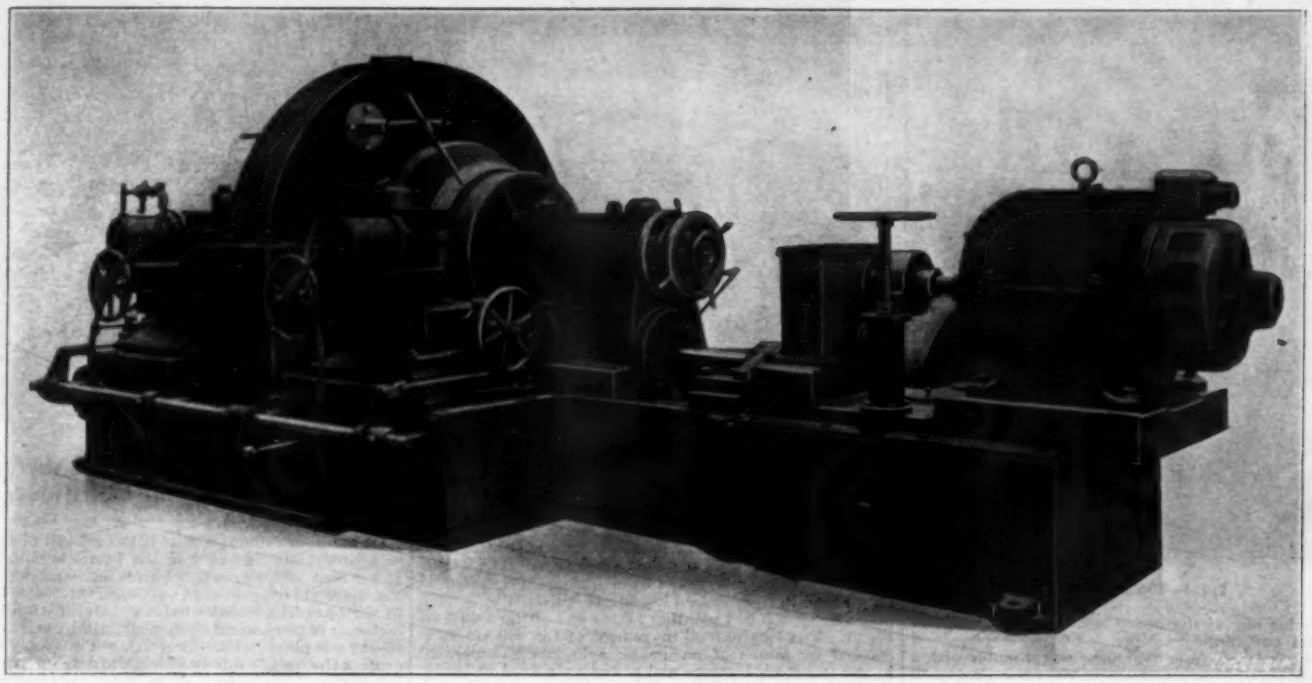


FIG. 3—FRONT VIEW OF PNEUMATICALLY-CONTROLLED CENTRALLY-DRIVEN WHEEL LATHE

The driving connection between the work and central driving system is established by means of three serrated members on each of the central face-plates. These serrated drivers are advanced by set screws and are caused to bite against the inner surfaces of the wheel rims. They are supported in boxes in such a way that the pressure which they exert against the rims is automatically adjusted to vary with the force applied to the tires by the cutting tools. Before the serrated drivers are caused to bite against the inside of the rims the tail stocks are moved inwards. Each of the tail stock face-plates is equipped with three wedges or dogs, which can be moved radially by means of set screws. These dogs are aligned opposite the serrated drivers and are advanced until they bear against the outer faces of the wheel rims. The pressure of the serrated drivers against the inner faces is by this means prevented from springing the wheels out of truth.

It will be gathered that this method of supporting and driving the work relieves the central driving spindle bearings of the weight of the work, and no doubt to some extent relieves them also of the weight of the central driving members themselves. The radial thrust of the tools

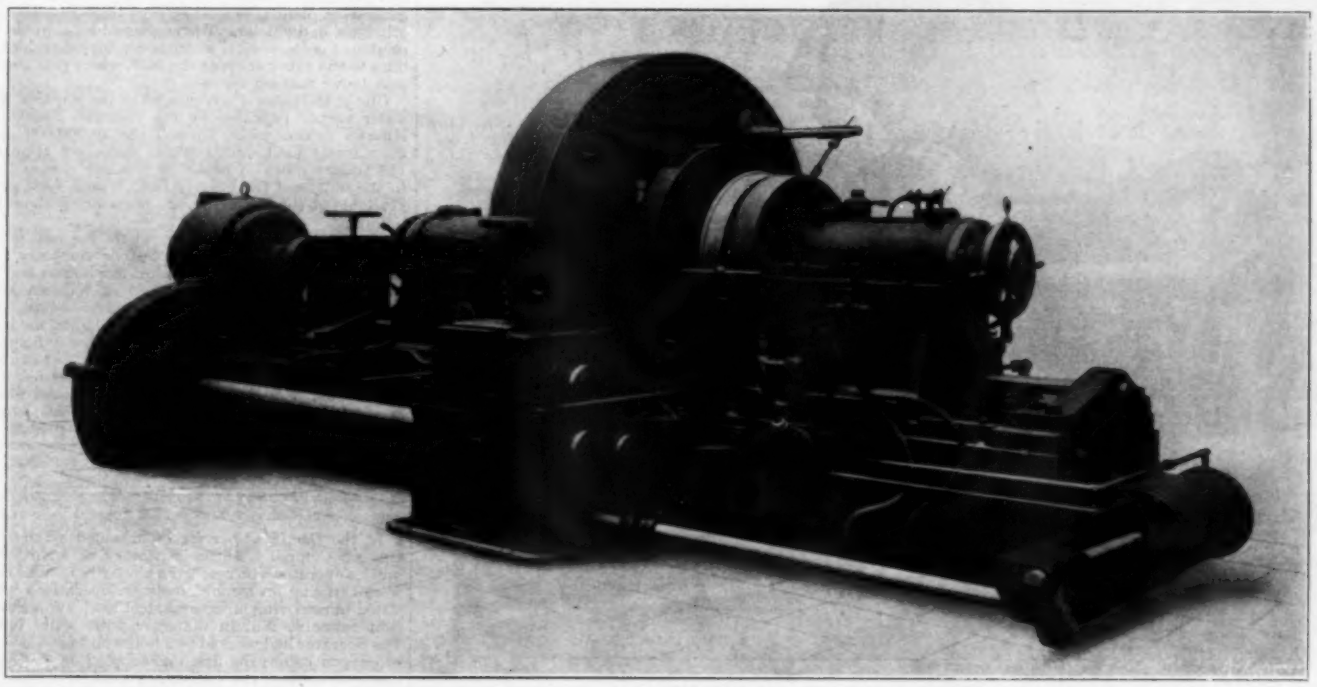


FIG. 4—REAR VIEW OF WHEEL LATHE

against the work is not transmitted to the driving spindle bearings, but is taken by the tail stock spindles. The longitudinal thrust from the tools and that produced by the tail stock face-plate dogs against the wheel rims is taken on large ball thrust washers at the ends of the tail stock spindles.

The bed of the machine is cast in one piece. On each side of the central face-plates, as can just be seen in Figs 1 and 6, it is formed between the tail stock shears with a ramp down which the chips fall into a pit beneath the bed. By means of this provision, it is claimed, it is practically

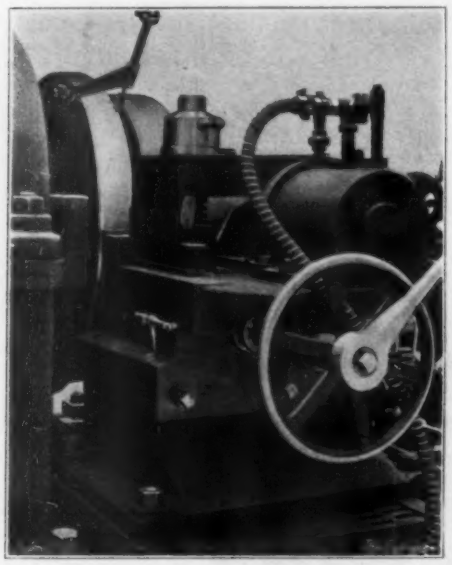


FIG. 5—TOOL SLIDE

impossible for any of the heavy and dangerous chips to reach a vital part of the machine.

The lathe is driven from a 50 horse-power motor with a speed variation of from about 450 to 900 r.p.m., mounted on an extension of the bed on the operator's right hand. From the motor the power is transmitted through a two-speed gear-box to a large shaft at the rear of the bed, whence it is carried to the pair of pinions meshing with the central gear wheel. All the gears in the drive are completely enclosed so that they may be run continuously in oil. The final speed transmitted to the central face-plates is from 0·7 to 2·7 r.p.m., corresponding on a 48in. wheel to cutting speeds of from about 9ft. to 34ft. per minute. With a constant-speed motor the machine can be fitted with a six-speed change gear-box.

Two tool rests are fitted to the front of the bed. They

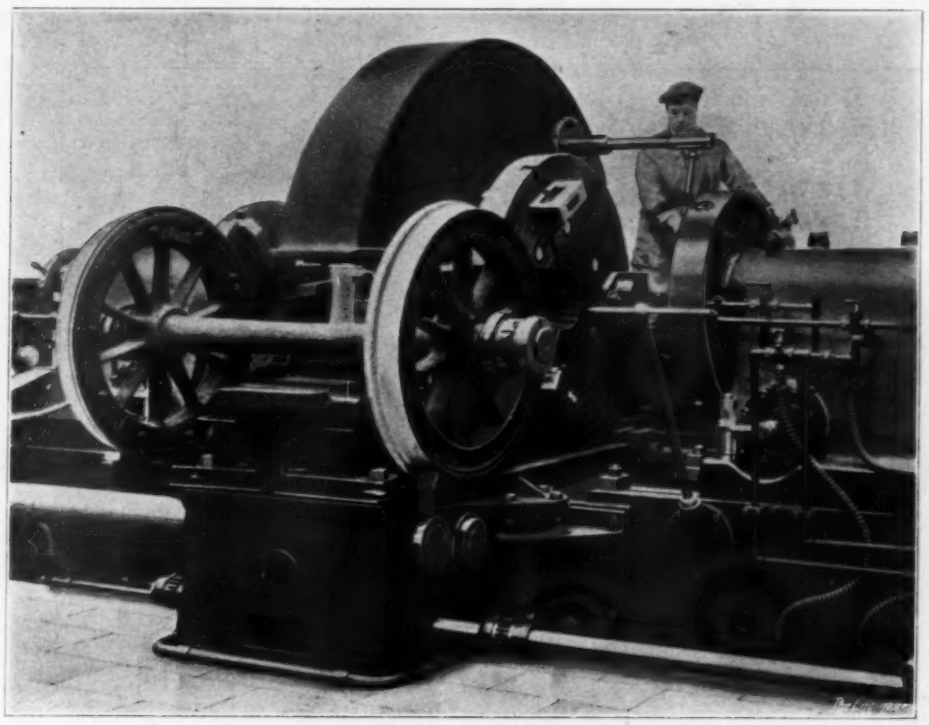


FIG. 6—REAR VIEW OF CENTRAL DRIVE ARRANGEMENT

are fitted with self-acting feed motions of ¼in., ⅜in., ½in., and ¾in. per revolution of the work. These feeds can be started, stopped or varied by means of a simple arrangement on the rests themselves. The tool rests are so designed that the feed slide operates at an angle of 1 in 20 to the centre line of the machine in order that the tread may, without special adjustment, be roughed out with the correct amount of coning. The top slide is, however, arranged to move at right angles to the centre line of the machine, so that the form tool with which the tire is finished may be fed inwards in the true plane of the wheel.

The pneumatic equipment of the lathe is arranged (*a*) to raise the wheels to the central position, (*b*) to slide the tail stocks into position up against dead stops on the bed, (*c*) to clamp the tail stocks in position, and (*d*) to clamp the tools in the tool slides. The lifting of the wheels up to the level of the machine centre line is accomplished by means of a pneumatically operated lifting track. The machine is sunk into the shop floor to an extent which brings the lifting track level with the shop track lines. The wheels can therefore be rolled on to the lifting track, which is then raised to the required height, as indicated by a fixed indicator on the bed pointing to one end of the axle—see Fig. 1. The longitudinal movement of the tail stocks is effected by means of pneumatic cylinders incorporated in the tail stock castings and piston-rods fixed to bridge pieces spanning the shears of the bed. In each tail stock there is also formed a pneumatic cylinder which is disposed crosswise. In this cylinder there are two opposed pistons. When air is admitted between these pistons the locking bolts on the tail stock are operated with equal force through the agency of crank levers. The clamping arrangements for the tools are illustrated in Figs. 2 and 5. It will be gathered that they consist of a pneumatic cylinder with a rack ram meshing with a pinion on a threaded stub which elevates one end of the clamping dog and forces the other with a multiplied leverage down on top of the tool. The clamping arrangements for the tools and for the tail stocks are such that the clamping remains effective even although the air supply should fail. The air supply is taken from a main which runs round the bed. In addition to the pneumatically operated clamps the tail stocks are provided with set-screw dead stops, which remove all possibility of the tail stocks slipping under the cutting forces and which can be swung out of the way of the tail stocks when they have to be withdrawn for unloading the lathe.

On the casing of the driving gear wheel a callipering device is fitted, consisting of an overhead rod on each side of the casing and a portable adjustable gauge—see Fig. 6—which can be transferred from one wheel to the other.

Exclusive of the electrical gear the machine has a net weight of approximately 32 tons.

THE KIPAWA WOOD CELLULOSE MILL

A Canadian Wood Cellulose Mill.

IT has been estimated that if the growth of the rayon, or artificial silk, industry in the future is equal only to 25 per cent. of the growth which it has exhibited throughout the world over the past ten years, the beneficial results to the Canadian sulphite industry, and in turn to manufacturers of mechanical equipment, will be marked. Even to-day one plant in Canada is engaged in supplying 50 per cent. of the world's supply of sulphite pulp for manufacture into rayon. This is the Kipawa Mill of the Canadian International Paper Company at Temiskaming, Quebec, which has an annual output of 75,000 tons of bleached sulphite wood cellulose.

Many interesting features of an engineering nature are embodied in the Kipawa plant. Built in 1920, it was specially designed and equipped for the manufacture of bleached sulphite wood cellulose. Served by unequalled resources of Northern Canadian sprucewood; an unlimited supply of water specially suited to the process; abundant hydro-electric energy; adequate research laboratories, and complete technical control, the Kipawa plant lacks nothing essential to the manufacture of its product.

The mill is situated at the foot of Lake Temiskaming, on the western border of the woodland province of Quebec. A power-house has been constructed a short distance away, where 24,000 horse-power is generated for use in the mill and auxiliary plants. The water flows to the power generating plant through two pipe lines, one 13ft. and the other 8ft. in diameter. Turbo-generators of modern design produce the electricity, which is conducted on high-tension lines to the sub-station at the mill, where it is transformed into lower voltage for use.

One of the natural advantages of the Kipawa Mill is the water supply provided by the immense reservoir of the Kipawa Lakes, which furnish the 40,000,000 gallons of fresh water used daily. These lakes are approximately 130 square miles in area. A conduit carries the water to the mill, and the gravity head is such that pressure is available at the highest points necessary without resort to pumping.

The town of Temiskaming, where the mill is situated, was laid out and developed by the company primarily with the aim of providing comfortable houses and pleasant surroundings for those employed at Kipawa Mill. The houses are of brick and concrete construction, attractive in design, and equipped with electric lights, modern water supply and sewage system. The electrically-lighted streets have concrete pavements. Throughout the town there is a high-pressure water system for fire protection, and there is provided a central station equipped with fire-fighting apparatus. There are in the town schools, churches, a hospital, tennis courts, community and private gardens, an amusement hall and shops.

IN the *Dominion Service Tips*, issued by the Dominion Oxygen Company, there is a story of an oxy-acetylene service operator who reached a place where some mechanics were carrying on some demolition operations which consisted in removing structural steel work supported by cast iron columns, 9in. in diameter with walls 1¼in. thick. The operator had worked two hours and used two cylinders of oxygen before the first one toppled over. The service operator showed the company's man how these columns should be cut by working on the second column. He started with the blow-pipe head tangent to the column circumference and heated a good-sized spot to the melting point; then he quickly opened the cutting valve and gradually raised the blow-pipe head until the tip was nearly perpendicular to the surface as the cut progressed around the circumference. At the same time the blow-pipe was swung back and forth slightly, much like he would move a welding blow-pipe in making a ripple weld. By moving the blow-pipe in this manner and not attempting to progress too rapidly it is possible to keep the region just ahead of the flame at sufficient temperature to kindle and burn in the cutting oxygen instead of being cooled by it. This column was cut in half an hour and with less than half a cylinder of oxygen, and the rest of them were cut by the company operator in the same manner.

Railway Matters.

THE disorganisation of the electrical services in the London area caused by frost after rain in the early hours of Wednesday, December 21st, was followed by a more serious stoppage on Christmas Day and Boxing Day, owing to a heavy fall of snow. Many trains were delayed, whilst some were snowed up and some derailed, but, fortunately, no serious accident occurred. Owing to the suspension of business for the holidays, there was less inconvenience than on the previous Wednesday, but the railway officials suffered greater anxiety.

WHILST the three trades unions with which railwaymen are associated are in favour of the railway companies having powers to own and operate road transport services, other unions connected with transport contend that the interests of their members may be adversely affected thereby. The Parliamentary Labour Party finds that the situation is becoming "very perplexing," and it has been decided that the executive of the party shall be asked to confer with the various trade unions in the transport industry with a view to the preparation of an official party policy on the question.

IN answer to a question addressed to him on December 21st, the Prime Minister stated that the Ministry of Transport and the Mines Department could not be dispensed with without legislation, and as he had received a continuous series of representations from traders, from transport organisations, from miners and other interests, it was evident that any such legislation would be controversial. It would not therefore be right to make demands upon parliamentary time out of all proportion to the actual savings likely to be effected. Answering a supplementary question, Mr. Baldwin said that it was a reasonable deduction to assume from his reply that the departments would go on as usual until the Government found time for legislation.

THOSE who know Sir Arthur Watson somewhat intimately were satisfied that some purpose was in view when, after holding the highest office possible on a British railway —that of general manager of the London, Midland and Scottish—he accepted the position of general manager of the Buenos Aires and Pacific Railway. That object was soon recognised—it was to prepare the way for Mr. Mervyn T. Ryan. It is now officially announced that Sir Arthur is returning to England and will be succeeded in Buenos Aires by Mr. Ryan. Mr. Ryan was a pupil of Mr. "Sam" Johnson, and became the locomotive superintendent of the Somerset and Dorset Railway. In 1919 he was made chief mechanical engineer to the Central Argentine Railway, which position he held until he went to the Buenos Aires and Pacific two years ago to be assistant general manager.

A CASE of the greatest importance to the railway companies of the United States has just been decided in the Federal Court of St. Louis. The point at issue, briefly stated, is that an amendment to the Interstates Commerce Act, contained in Sec. 422 of the Transportation Act, 1920, allows the Commission to approve of rates that will enable carriers, *i.e.*, railway companies, under honest, efficient and economical management and reasonable expenditure for maintenance, to earn an aggregate annual net railway operating income equal, as nearly as may be, to a fair return upon the aggregate value of the railway property of such carriers. The argument of the railways is that the valuation of to-day is intended, but the Commission holds the contrary view, and the latter body has obtained judgment in its favour. The action has been taken as a test case, and is now to be carried to the United States Supreme Court.

THE attitude of the main line railway companies and of the Metropolitan Railway towards the scheme for pooling London traffic was, we hope, clearly indicated in the last paragraph in this column of our issue of November 4th. It must not be forgotten that, besides the Metropolitan—which carries over 20 million workmen yearly—there is the very heavy traffic into London brought by the Southern and, to a lesser degree, by the London and North-Eastern. The main line companies must therefore be considered, and towards that end they and the Metropolitan have prepared a scheme which has recently been laid before the London Traffic Advisory Committee. As *The Times* of December 21st remarked, when mentioning this fact, "There is general agreement that the prospect of carrying the scheme through Parliament will be enhanced considerably if the support of the main line railways can be obtained."

THE report of the South African Railways for the year ended March 31st last shows that the earnings were 0·33 per cent. less than in the preceding year, whilst the expenditure increased by 3·74 per cent. The passenger traffic was the highest on record, but the tonnage decreased by 2·17 per cent. The ratio of working expenditure, including depreciation, increased from 77·5 per cent. to 80·6 per cent. That was in part due to tariff reductions, in part to the cost of working new lines and in part to the cost of revised staff conditions. In the report Sir William Hoy—who retired on November 11th last—referred to the findings of a select committee of the Parliament of 1926 which inquired into railway electrification matters. The committee expressed the opinion that the system of control of the work adopted on Sir William's recommendation was the cause of friction and lack of co-operation between the railway engineers and the supervising officers of the consulting engineers, and that that resulted in increased expenditure. The railway administration, in its reply, agreed that expenditure might have been saved had it been possible to devise a system of organisation which would have eliminated dual control entirely. It showed, however, that a certain amount could not be avoided except by running the risk of greater difficulties and incurring still heavier cost. The scheme, in the opinion of the administration, was the best that could be devised at the time, and it was most unlikely that any other scheme would have given better results. Sir William, in quoting these opinions, concludes by observing that he has still to learn of a more practical or economical solution of the difficulty, and that no one has yet been able to suggest an alternative system of organisation, suited to the special conditions in Natal, which would have enabled the works to be carried out with equal efficiency at a lower cost.

Notes and Memoranda.

THE plant of the Ottawa Power Company at Bryson is to be doubled immediately and increased three-fold within the next two years.

THE High Main seam, which is being developed by the Wallsend and Hebburn Coal Company, has a thickness of between 6ft. and about 9ft. It is the seam from which the famous "Wallsend Best" was obtained, and has not been worked since 1820, when the workings were flooded out. The seam has been reached from the Edward Pit.

IN the *Engineering News-Record* of December 8th there is a brief account of the demolition of the wreck of a 2600-ton steamer, which had sunk more or less in the fairway of one of the passes into the Mississippi River. The vessel sank in about 45ft. of water, and her wreck was in the way. It required about 28½ tons of explosives to remove the wreck by blasting out holes in the bottom into which the scrap could be sunk.

IN the *Engineering News-Record* there is a description of the arrangement of two Venturi meters coupled in series to measure widely fluctuating flows of water. The smaller meter really forms a by-pass arranged beneath the conduit, so that when the conduit is not full the water passes downward through this meter. With greater flows the water passes through the small meter and the conduit and then on to the large meter.

THE use of duralumin for mine tubs and coal baskets at collieries instead of steel is, according to the *Iron and Coal Trades Review*, extending rapidly in Germany. The tubs and baskets of duralumin are said to weigh only about one-third of steel, and to effect a considerable saving in power, wire rope and other costs. As many German mines are rather deep, the new metal, which is acid-resisting, is being introduced. Tubs made of this metal were exhibited by the Emil Wolff firm, of Essen, at the recent exhibition of working materials in Berlin.

IN a lecture on "Hardening and Quenching Throughout the Ages," given before the Junior Institution of Engineers recently, Mr. P. J. Haler made many references to early literature indicating the extent of the contemporary knowledge of the hardening of metals. The hardening of weapons appeared to be known at an early date, and the merits of different quenching solutions were mentioned. For instance, Virgil made reference to a glowing sword dipped in the ice-cold river Styx. The superiority of Toledo blades was attributed to some quality of the water of the Tagus used for tempering the steel.

A NEW Morgan rod mill recently completed and put in operation at the South Works of the American Steel and Wire Company, Worcester, Mass., U.S.A., is said to roll rods at the rate of 4000ft. a minute. This new mill is the first in the United States to produce rods in 400 lb. bundles. The mill, which is described in the *Iron Age*, follows the general line of all Morgan double-strand mills, except that the rod is finished in separate trains of rolls. This means that, while two billets pass side by side through the roughing and intermediate rolls, each of the two finally enters a separate train of rolls. The arrangement of split finishing makes a safer mill to operate, and also permits rolling smaller and more nearly round rods than is possible in a mill rolling a double line of rods all the way through.

DEALING with the proposal of Professor Schwarz to convert the Kalahari Desert into a lake, for irrigation purposes, the *South African Mining and Engineering Journal* says:—"When one examines the larger claims made by the enthusiastic author of the project, one wonders very much if they could be realised. It is suggested that climatic conditions would be improved over a large area, even down into the Cape Province. Improved climatic conditions suggest an improved rainfall. Unfortunately, rainfall is the result of a combination of several factors. The presence of sheets of water, with evaporation therefrom, does not seem sufficient guarantee that rainfall will be improved either in that neighbourhood or in adjacent areas. Prevailing winds, tempertaure conditions, and the presence of mountains have, we suggest, to be taken into account. We welcome this further contribution to the discussion, by Professor Schwarz, but with all due deference to one who has made the project his study and his hobby for a number of years, we are somewhat doubtful about the far-reaching effects that are held out as the big attraction of the undertaking. Nevertheless, on the one point of bringing water to an arid region, the scheme is worthy of attention, provided that the cost is within reason."

A DESCRIPTION was given recently to the South African Institution of Engineers, by Mr. J. Forman, of how natural CO_2 gas was liquefied with an inadequate compressor by compressing the gas from the bore-hole into nineteen flasks to twenty-five atmospheres pressure. The inlet pipe of the compressor was then disconnected from the bore-hole and coupled up to one of the flasks. In a few minutes the gas in this flask was pumped out, and this process was repeated until fifteen of the flasks contained gas at forty atmospheres pressure. The same process was again repeated until it was estimated that 80 lb. weight of gas had been pumped into the coils of the machine and the one flask which was attached to the final coil. This flask, which was being filled, had been placed on a scale, and at this stage the scale showed an increase of only 5 lb. in weight. It was therefore apparent that most of the liquid gas was contained in the coils of the machine. In order to overcome this it was necessary to evaporate the gas in the coils and condense it in the flask. The engine and compressor were stopped and all valves, except that between the coils and the flask, being filled, were closed. The hot water from the cooling tank of the engine was led into the cooling tank of the compressor, causing a rise of temperature there, and at the same time the gas flask was cooled by the application of wet sacks. Immediately the temperature of the coils began to rise, the pressure in the plant increased considerably, and the flask weight rose very rapidly. Within five minutes the first flask of natural gas in South Africa was filled ready for delivery. Twelve flasks were filled in this manner,

Miscellanea.

IT is proposed to put up a petrol refinery near Durban-Natal, at a cost of £750,000.

ARRANGEMENTS are being made for the provision of a commercial aerial service between Shanghai, Hangchow and Nanking.

WORK has been started on the cold storage which is to be erected at Durban, Natal, at a cost of £160,000. The plant has already been ordered in England.

IT has been decided to put up a factory for the manufacture of Ford cars in Yokohama. The output is to be 200 cars a day, and the capital expenditure 1,000,000 dollars.

A PLAN to remedy the high water danger at Brandon, Manitoba, has been proposed by H. M. Rice, the main feature of which is to straighten the course of the Assiniboine River.

IT is now announced that it will probably be the middle of next summer before the report of the engineers who are investigating the construction of new road bridges across the Forth and the Tay will be ready for submission.

IT is suggested that a new harbour should be constructed at Fortpond Bay, Montauk Point, Long Island, with the object of providing a four-day Transatlantic service. The cost of the necessary breakwaters would be about £1,500,000.

THE demand for electric power in Liverpool now amounts to about 79,000 kilowatts, and is expected to rise to 100,000 kilowatts in 1928–29. It has consequently been decided to expend £305,000 on extensions of the Lister-drive power station and to interconnect the various stations in the district.

THE Durban Town Council has authorised the expenditure of a million pounds, as follows:—Water supply, £330,000; electric supply, £225,000; roads, streets and public works, £200,000; storm-water sewers £100,000; beach development, £60,000; telephones, £30,000; sewerage extensions, £30,000; tramways, £15,000; and abattoir additions, £10,000.

AN important extension of the road motor services of the South African Railways has, according to *The Times*, been opened to traffic. The route—one of the longest worked by the Department—is from Potgietersrust to Van Wyksfontein, near the Bechuanaland border, a distance of 170 miles. As it will be impossible to cover the journey by motor omnibus in one day, a stop overnight will be made at Steilloop, where a new bridge was recently built.

THE preparation for sinking the vertical shaft of the Sub Nigel gold mines, Transvaal, are well in hand. The steel head gear has been ordered, as well as other necessary permanent equipment, including the winding engine, all of which, it is hoped, will be erected and ready for use by March, 1928. The shaft is already down 20ft., and will be sunk to a depth of 100ft. by temporary equipment, so as to complete the collar set and have everything ready for sinking proper in April, 1928.

TENDERS are being called for by the authorities of Hamilton, Ontario, for one 10,000,000-gallon per day steam turbine-driven horizontal centrifugal pump and one 400 H.P. horizontal water-tube boiler, hand fired. Alternative tenders are also being invited for one oil engine-driven pump and accessories. It is understood that the contract for the standby equipment will be awarded on the basis of capital expenditure, including all alterations and additions necessary to the existing buildings.

A MESSAGE from Aden states that a supply of fresh water has been obtained at Sheikh Othman. Water from a depth of 1600ft. is flowing from a bore-hole at the surface, and the supply is capable of giving 100,000 gallons per day by means of pumps. The discovery is very important, as the population in Aden, numbering some 40,000, has had to depend for its water on the costly process of distilling sea water, which had also to supply the needs of over 1000 vessels which enter the port annually.

A DISCOVERY of importance to Pembrokeshire has, according to the *Iron and Coal Trades Review*, taken place at Hook, near Haverfordwest, where a seam of coal was struck after a search extending over a period of nearly twelve months. The seam is 8ft. 6in. to 9ft. thick, and was discovered through the efforts of Mr. T. Harcourt Roberts, the managing director of the Hook Colliery Company, Ltd. The main seam has been struck at Hook, Pembrokeshire. The seam was penetrated to the extent of 7ft., and later it was definitely established that it is 9ft. thick. The measures now struck embrace some 100 acres.

IT is announced by "Altaipolimetal," the Russian State Trust exploiting the Altai Mines, that on October 12th the first water-jacket unit of the lead-smelting plant was started up. The Russian Press hails this apparently insignificant fact as a matter actually of the greatest importance from the point of view of Russian industry. It shows that in the comparatively short time of two years, in spite of the complete lack of transport, the abandoned flooded Ridder mines have been unwatered and put on a producing basis, and the concentration plant—which is treating one of the most complicated silver-lead-zinc ores known to the mining world—started up and successfully operated.

A BRITISH syndicate, representing large capital resources, has commissioned Mr. Gilbert Lodge, whose firm represents Armstrong, Whitworth and Co., Ltd., and other British manufacturers, to report on the prospects for the establishment in Australia of a large locomotive manufacturing plant. Mr. Lodge states that if the syndicate decided to establish such works in Australia, they would probably be situated in Sydney, with a water front site. The works would be able to manufacture engines and rolling stock to suit the different railway gauges, and would ship the manufactures to the various States without difficulty. Mr. Lodge will discuss with the Federal Ministry a proposal that the Ministry should arrange for the manufacture of aeroplane engines under royalty to the British designers and makers, with a view to making Australia independent of oversea countries in the event of war.

NEW ROAD BRIDGE BETWEEN NEWCASTLE AND GATESHEAD

(*For description see page* 728)

FIG. 1—GATESHEAD ABUTMENT FROM RIVER
Arch erected to p.p. 19-20, and first set of cables in position.

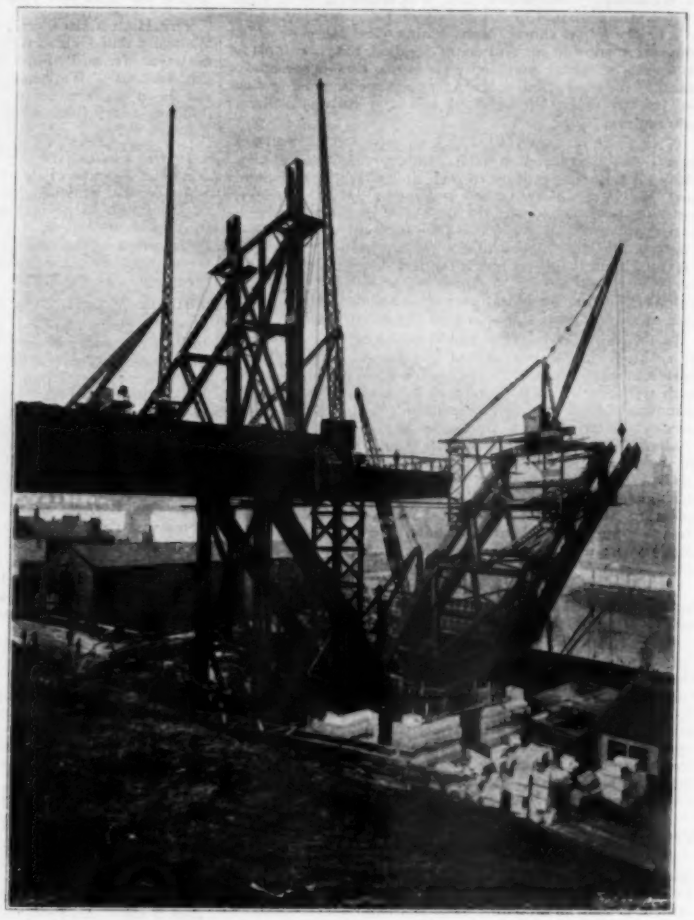


FIG. 2—GATESHEAD ABUTMENT, LOOKING NORTH-WEST
Arch supported by cables at p.p. 21.

FIG. 3—NEWCASTLE ABUTMENT
Main bearings and bottom sections of arch supported on timber trestles.

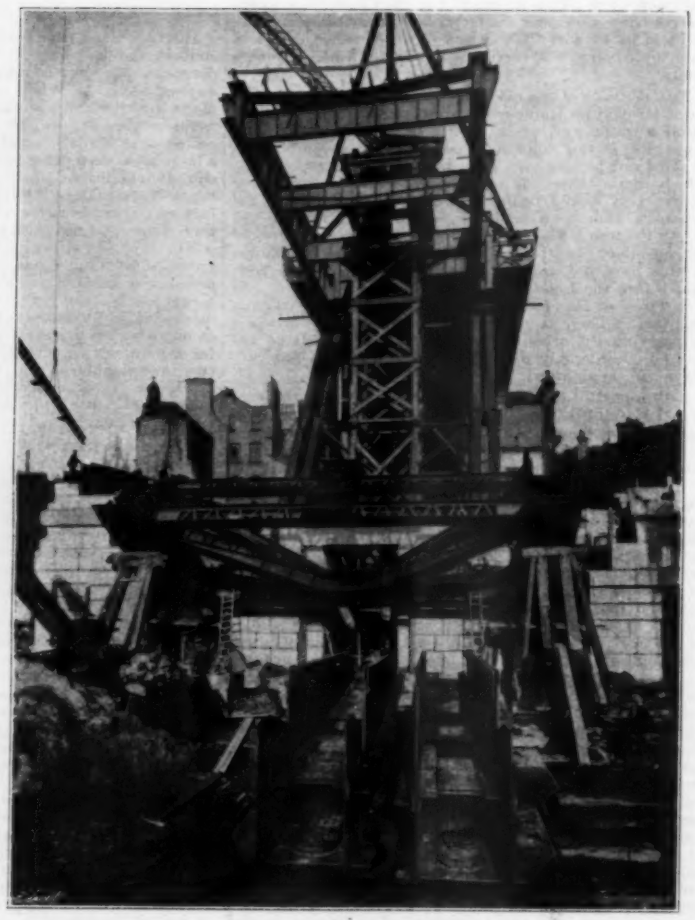


FIG. 4—NEWCASTLE ABUTMENT, LOOKING NORTH
Main bearings and bottom sections of arch supported on timber trestles.

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The Metallurgist

THE DECEMBER NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

DEATHS.

On December 27th, at 2, Princes Gate, East Liverpool, ARTHUR BROMLEY HOLMES, M. Inst. C.E.

On December 20th, 1927, suddenly, at his home, Petteridge Place, Brenchley, Kent, JAMES HENRY HEAP, late Chief Engineer, Indian State Railways, aged 59 years.

THE ENGINEER.

DECEMBER 30, 1927.

Industry and Education.

AFTER two years of labour an Executive Committee, appointed by a Central Committee which includes a large number of teaching and technical associations, institutions and societies, has issued a report. The Committee had very little money and no powers. It could not require replies, it could only invite them. It decided therefore to issue a questionnaire. Not a very good plan, but the best that the circumstances would permit. The response was gratifying; many of those to whom the questions were addressed answered them, and some took a great deal of pains to make full replies. In particular, the Federation of British Industries "assembled" a report from the replies of a number of associations and from the individual opinions of manufacturers in many trades. It compiled its own questionnaire, and as the questions were of a broader character than those sent out by the Executive Committee, so the answers were also founded on a wider basis. It is perhaps the most valuable part of the report, though the other replies, which show the actual conditions that obtain in technical schools throughout the country, have considerable statistical value.

It is always a little difficult to define exactly what is meant by the term "technical education." On the one hand, we have the technical education which is given in municipal schools and colleges, and in schools which are designed essentially for vocational training; on the other, we have the colleges of university standing, which are less concerned with technology than with the science underlying it. There is no hard-and-fast demarcation between these two branches of knowledge, and in consequence there is no perfectly clear distinction between the schools. Yet there is an undefined distinction which is indicated rather by the management or organisations which conduct the schools than by the schools themselves. In this case we think it is fairly clear that the Committee had in mind the colleges which for the sake of a name we may call of municipal standing, and not those of university rank. The discrimination is of importance, for it is obvious that the nature of the education which can with advantage be given to youths who, whatever the future may hold for them, must at a relatively early age earn their own livings by handicrafts, is different from that which should be open to those who are well enough off to devote more years to their training. This distinction being made clear, let us consider what the reporters have to say on the co-operation between industry and technical education. We may note, in the first place, that their remarks resolve themselves into a series of questions. They make few, if any, definite recommendations, and all that the reader can derive from their report is that technical education is in an indifferent condition. It is known that the Central Committee desired that the whole matter should be investigated by a Royal Commission. Perchance the report is intended by its inconclusive nature to show the necessity of such a Commission. Amongst its cloud of questions we can select but those which appear to be of crucial importance. "Have we," asks the Committee, "a national policy, or are we drifting in the wake of general educational progress? Has technical education been able to adapt itself to the new conditions? Has it had to conform too much to the main advance? Is the total effect a patchwork or an organic whole? Wasteful or efficient? Should education be organised by industrial areas or by areas of local education authorities? Should the professional associations not take a larger share in shaping curricula and advise on training in workshop, in office, in college? Or must we wait until the spirit moves them individually? How can industrial organisations (federations and unions) and local industrial experience be brought into close co-operation with those who provide the funds and control the schools and colleges? The prejudice of business against university men is slowly dying down; can the process be accelerated? Finally, which Central Authority is to direct the operations of the intellectual forces?" The mere repetition of these questions may show that further inquiry is called for; on the other hand, it may show no more than that the reporters have been carried away by their love of organisation. They would, we expect, like to see everything connected with education neatly cut and dried, all the parts dovetailing together quite neatly with, we gather, a single organisation keeping an eye on the whole. We must confess, for ourselves, that we are not convinced that such a plan would, indeed, be the best for the country. In the old days the Science and Art Department was an organisation of the kind. It failed just because it lacked freedom of movement, freedom for the imagination of progressive men, freedom to depart from stereotyped methods. When Finsbury Technical College was established it broke away from conventions; it started out on quite new lines, and it enjoyed for years a remarkable success. We believe that the system of the Board of Education does not encourage departures from its schedule, though at times they are tolerated. Now and then a headmaster with novel ideas springs up. He breaks away from orthodoxy, and, if his plan is a good one, he makes a name for his school. We want more men of the kind, and it is doubtful that they are more likely to be encouraged by a single central organisation than by the independence that now prevails in technical schools. On the whole, we should say that it is best to allow each headmaster to control, as far as may be, his school in accordance with the local conditions, but—and this is the important point of the report, although it is submerged in other matters—a closer relationship between the schools and the industry they supply is needed. The report takes the view that there is very little touch between the two, and a couple of schools which have employers on the governing body are mentioned as exceptions. It is hardly conceivable that any school can be wholly detached from the local industries; but there can be no doubt that some closer bond would be advantageous and the examples presented by the Armstrong College and the Manchester College of Technology might be

examined. "If each industry," said Sir Arthur Balfour, on the education committee which bore his name, "would consider from its own standpoint what technical education can do for it, would survey the existing facilities, and see what gaps need filling and what developments are desirable, and would take an active interest in the schools, and give assistance in their conduct, it is probable that substantial improvements could be suggested."

If, as we have shown, the report gives very little help towards a definite policy or line of action, it does, by the series of questions which it propounds, show that there is at the present time a great deal of uncertainty, and that there are not a few matters which might with advantage to the country be examined with more care than was possible to the Committee. But we are not at all certain that Government activity is called for or that a higher degree of "organisation" would be really beneficial. What is wanted is a more intimate liaison between industrialists and those who give technical education. That must be a voluntary action; it cannot be done effectively by Government command. It can only come about by local endeavours; by convincing employers that the education of the youths who will enter industries is of importance to the welfare of trade. Once secured, it would probably do all that is needed to put education on the right road. In the words of the Federation of British Industries, "It is felt that this relationship would eradicate many of the existing weaknesses, and at the same time tend to expand the field of technical education to cover the whole technique of industrial and commercial life."

Actions for Negligence.

It is a remarkable fact that our English law reports seldom record a case in which an engineer is charged with negligence. To suggest that engineers never are negligent, would be somewhat too flattering to the profession; rather may the explanation be found in this—that the position of the engineer is usually one in which he cannot be charged with negligence. It is not that he is wholly immune from action at law. Unlike a member of the Bar, he can be brought to book if he fail to discharge the duty which he owes to his client. His position *quoad* his employer and the contractor resembles very closely that of the architect *quoad* the building owner and the builder. An architect, in the discharge of some of his duties, is the agent of, and as such can be held liable to, the building owner. But for the most part he is in the position of a quasi arbitrator—and in that capacity he is not liable for negligence. In the matter of granting certificates, for example, he so acts, and it is conceived that the position of an engineer is precisely the same.

The immunity of an architect in such circumstances was emphasised in a case recently heard in the Court of Appeal. A District Council had made a contract with certain builders for the erection of a number of houses. A clause in the contract provided that no certificate of the architect, except for the final balance, should be conclusive evidence of any works having been satisfactorily carried out, or of the value thereof. The materials were to be supplied in part by the builders and in part by the Disposals Board, and the architect, by inadvertence, certified a sum to be payable to both these bodies for the same material. The District Council being unable to recover what it had overpaid, sought to recover that sum from the architect by way of damages for negligence, but although a judge of first instance held him liable, the Court of Appeal found in his favour. It will be observed that in this case the action was based upon an alleged negligence in granting an interim certificate; it has, however, been clearly established that even in the granting of his final certificate the architect is in the position of an arbitrator, and as such is immune from an action for negligence. In the leading case of Chambers *v.* Goldthorpe, the late Lord Justice A. L. Smith used these words: "I think that the effect of his [the architect's] agreeing to act under the contract was that he undertook the duty towards both parties of holding the scales even, and deciding between them impartially as to the amount payable by the one to the other. I cannot think that the plaintiff's duty was only to protect the interests of the building owner—in other words, to cause the building owner to pay to the builder as little as possible for his work." As with the architect, so with the engineer. It is one of the glories of his profession that he is there to deal fairly as between employer and contractor. If he so acts, the law will protect him. But it must not be assumed that this immunity extends to protect the engineer in the discharge of every duty. No excessive demand must be made upon him, but he must evince a reasonable degree of skill. It was laid down by an old judge that: "A person who enters a learned profession undertakes to bring to the exercise of his business nothing more than a reasonable degree of skill and care. He does not undertake, if he is an attorney, that he will gain a cause at all events; or, if he is a physician, that he will effect a cure; nor does he undertake to use the highest possible degree of skill. There may be persons who have higher education and greater advantages than he has, but he undertakes to bring a fair, reasonable and competent degree of skill to the discharge of his duties." It is obvious that an error made well within the standard or proficiency here laid down may be fraught with grave consequences. In a case which arose in 1890 certain engineers brought suit against a local board to recover fees amounting to £521 for preparing surveys, schemes, estimates, &c., in connection with certain drainage work. The board declined to pay, and counterclaimed for negligence in the preparation of bills of quantities, faulty measuring up, and careless supervision. A sum of over £4000 was awarded to the board by way of damages, made up of sums overpaid owing to the quantities having been over-certified and the cost of doing bad work over again. And the Court of Appeal upheld the judgment of the lower court, notwithstanding that the whole amount of the contract which the engineers were instructed to superintend was a sum of about £5000! It were impossible, of course, for an engineer employer in relation to a large contract to supervise everything himself. He must rely to some considerable extent upon measurements, &c., of others. But here, as in similar cases, where a man delegates his duties, he remains responsible. The maxim *respondeat superior* applies. In a Canadian case, heard in 1917, it was decided that when a civil engineer is called upon in his professional capacity to make estimates, and either from want of skill or negligence his report or estimate is incorrect, he is liable to his employer for the injury thereby occasioned; it is no excuse that he relies upon the information and advice of another engineer who has made experiments and investigations of the kind required.

It will be noticed that we had to go back to the year 1890 to find an English case bearing on the subject of negligence in the case of an engineer, and to 1917 to find a Canadian example. This dearth of authority bears witness to the fact that actual cases of negligence are few and far between, and redounds to the credit of a great profession. It must be that in the routine of the engineer's office the maxim, "Say not that 'This is great' or 'This is small'; each task may hold your fate. Fulfil them all," has been well and truly appreciated.

Literature.

The Higher Coal Tar Hydrocarbons. By Arthur Ernest Everest, D.Sc., Ph.D., F.I.C. London: Longmans, Green. 1927. Price 18s. net.

The appearance of a book like this gives us much food for thought. A number of the cyclic hydrocarbons forming the author's subject has been known for a very long time, but this is the first work of any magnitude dealing with the subject exhaustively. The practical reason for its appearance is that these hydrocarbons have been found to give rise to new colouring matters and other substances of commercial importance. Such has the history of organic chemistry been ever since the discovery of Perkin's magenta, viz., the commercial possibilities have diverted the trend of the activities of the chemist, and the various theoretical developments of organic chemistry have been secondary considerations. One after the other benzene (benzol), anthracene and naphthalene became the *fons et origo* of prospective wealth to be extracted from coal-tar, phenol, cresol, &c., coming along with them. Naphthalene hung back for a long time, as it offered difficulties on account of the many isomeric compounds which gave science a chance. The literature relating to these three hydrocarbons and their derivatives grew to appalling dimensions, and that raises the question whether the appearance of the book under review is a sign of exhaustion of the possibilities of the better-known hydrocarbons. Probably it is within the limits of the comparatively few and simple methods of organic synthesis in use even to-day. The discovery of a new method of procedure may alter all that, like Sandmeyer's reaction, once upon a time, opened a new field of enormous importance and scope. In the meantime, perhaps, the author has done a wise thing in compiling our knowledge about what have hitherto been looked upon as trifles by the way. The bulk of his book treats three groups of hydrocarbons, viz., acenaphthene, fluorene and phenanthrene, and their still higher homologues. All these are characterised by carbon rings, combined into treble cyclic complexes like anthracene. In the first two there are two hexa-cyclic rings and one penta-cyclic one. Phenanthrene has three hexa-cyclic nuclei, like anthracene, but differently arranged. It is really astounding to see what a lot is known about these hydrocarbons to-day, when one considers that in most works on organic chemistry as late as 1890 they were mentioned with next to no comment.

The chapter on acenaphthene is very interesting on account of certain similarities with the chemistry of naphthalene, from which the hydrocarbon has been synthesised. The proof of the constitution of acenaphthene by Bamberger and Philip (1887) is given, proving its relationship to naphthalene, which at that time was *the* thing in many laboratories of note. With regard to the chlorine compounds, acenaphthene seems to stand to-day, where naphthalene stood then, *viz.*, far from all of the possible isomers are known. One of the sulphonic acids gives by fusion with alkali a hydroxy-compound, which, like the corresponding naphthol, gives rise to colouring matters, &c. &c. The analogy of amines, nitro-compounds, &c. &c., carries this remarkable similarity further. Quinones give vat-dyes like anthraquinone, and evidently the whole gamut of research on other cyclic hydrocarbons has been run with a fair amount of success. Condensation products with "cis-trans" isomers have also been studied; in fact, there is a promise of plenty of literature in that line in the future. From a less specialised point of view, it is interesting to note that acenaphthene combines directly with potassium, and, according to one source, with magnesium. There is a search going on for all kinds of organo-metallic compounds for therapeutical purposes, and there may be a chance of finding something useful in this field, if other less positive metals could be made to enter in combination.

The chemistry of fluorene and phenanthene is also a revelation with regard to the amount of work done in comparative silence by the organic chemists. To the chemist there is a certain amount of interest in seeing the amount of complication, which the combination of nuclei gives rise to with regard to isomers, &c., but it would probably carry us too far to go into further details in this short review. The author has given a vast amount of subject matter covering the physical properties of a great number of compounds, as well as pointing out many colouring matters, &c., of practical interest. It is a book appealing to the research worker by its concise and systematic rendering of facts; and is one which may be used with advantage in conjunction with Beilstein and probably even amplify that indispensable, never-ended compilation. Thirty years ago the appearance of such a book in English as an original would have been a phenomenon, to say nothing of the publisher's hazards. Industrial organic synthesis has since then become a serious business in this country, and to-day the number of chemists engaged in organic research has reached or passed the thousand, and the number is growing. No research chemist can afford to be without access to accurate knowledge of the most out-of-the-way substances. Even the physical chemist may find something of interest. The reviewer noticed, for instance, in the end of the book that the crystals of the hydrocarbon benzerythrene become electrified on heating, thus adding another to a fairly small class of substances. Such little things make these descriptions of, comparatively speaking, rare substances, of a potential value which it is not easy to estimate.

The author is one of the pioneers of the English literature of this kind, and deserves every credit for the persistently objective style and strict adherence to the usual order of arranging the derivatives of the various hydrocarbons which makes it easy to find such information as is wanted. Both he and the publishers are to be congratulated on producing such an excellent and well-printed book at the low price given.

SHORT NOTICES.

Munro and Jamieson's Pocket Book of Electrical Rules and Tables. London: Charles Griffin and Co., Ltd. Price 18s.—The twenty-second edition of this well-known handbook contains a considerable amount of new matter on various branches of electrical engineering, such as submarine cables, automatic telephony, balancers, improvement of power factor, telephonic transmission, electron tubes used as relays, transformer engineering, wireless telegraphy and telephony, dynamos and magnetic measurements, &c. Articles have been contributed by various well-known engineers, specialising in different branches of electrical work. Professor C. L. Fortescue, for example, has written a long chapter on "Wireless Telegraphy and Telephony," while Mr. Thomas Carter is responsible for the sections on balancers and the improvement of power factor. In all, seventeen eminent specialists have contributed articles, including Dr. Alexander Russell, Mr. R. Appleyard, and Dr. S. Parker Smith. Dr. Alexander Russell and Dr. W. E. Sumpner have provided some very useful material on transformers and, taken as a whole, the book is well up to the usual standard.

Rural Electrification.

WHILE some engineers are far from enthusiastic about rural electrification, and do not believe that the supply of electricity to farms is likely to be a very remunerative business, others maintain that rural electrification will ultimately prove a boon to supply undertakings. At present very few British engineers can boast of rural electrification experience, and

FIG. 1—LINE WITH 3-CORE CABLE CONNECTION.

much of what is said and written in favour of it is based on work carried out abroad, although in some parts of Great Britain a certain amount of progress has been made.

One of the most successful engineers in this particular field appears to be Mr. J. S. Thomson, manager of the Fife Electric Power Company. This company has at present about 150 miles of E.H.T. overhead lines and cables, which are tapped at no fewer than 155 points for the purpose of giving supplies, and consequently there is approximately one transforming point for every mile of cable and line.

Farmers in the area covered by the Fife Electric Power Company's overhead lines and cables appear to be quite eager to use electricity, and the agricultural load is an appreciable asset to the supply company. Not only are farmers and others in the locality prepared to face the expense of wiring their premises and equipping them with motors, &c., but they are also often willing to spend money on equipment for giving the supply. In the case of farms and other isolated buildings, within the vicinity of the E.H.T. lines and cables, the consumer provides a brick pillar close to the company's line or cable, and also the necessary transformer and the low-pressure line or cable between the transformer pillar and the premises. Part of the company's distribution system works at a pressure of 3000 volts, but for the most part the system is operated at 6600 and 12,000 volts. For small supplies a cheap form of brick transformer pillar is generally provided, as shown in the drawings, Figs. 2 and 3. It is constructed of 9in. brickwork, with cement rough-cast on the outside, the roof being composed of reinforced concrete about 6in. thick. In certain cases an ornamental roof is provided. The sizes of the pillar are shown on the drawings, Figs. 2 and 3, the cost being £18 and £23 for 25 and 125-kilowatt transformer pillars respectively.

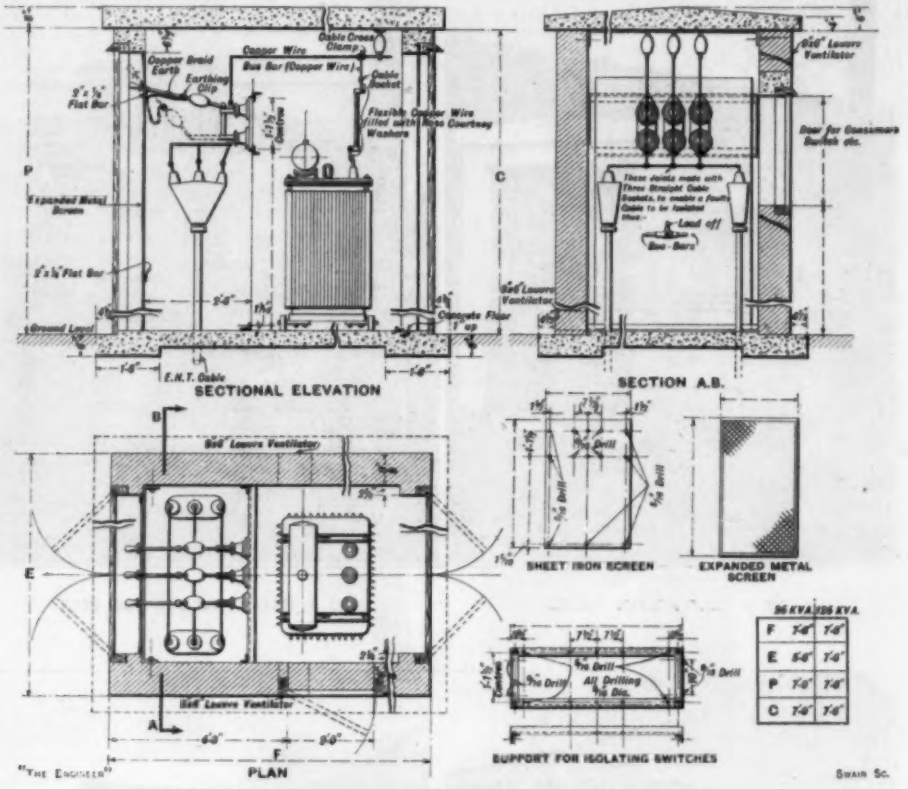


FIG. 3—TRANSFORMER PILLAR WITH ISOLATING SWITCH

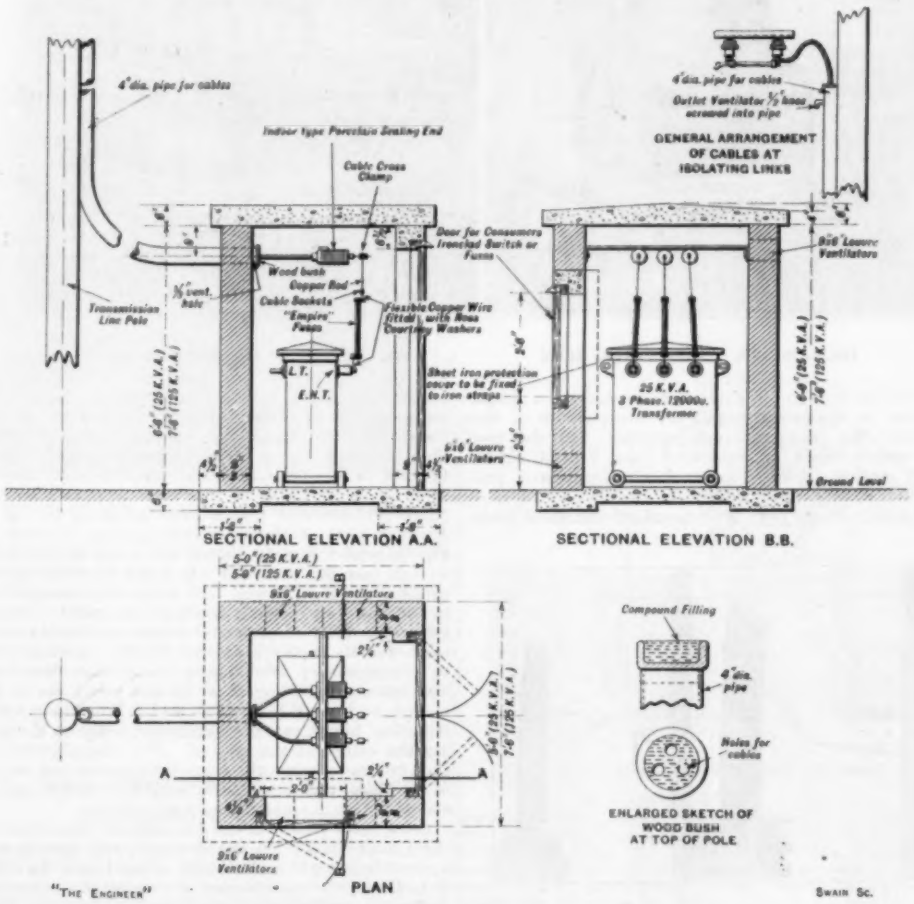


FIG. 2—TRANSFORMER PILLAR WITHOUT ISOLATING SWITCH

In order to make the connection with an overhead line, a set of three-pole isolating switches is mounted at the top of the pole and one side of these switches is connected with the overhead wires, whilst the other side is either connected to a three-core cable dividing box or to three single-cable pole dividing boxes, the connection to the pillar with either three-core paper-insulated lead-covered and armoured cable or

FIG. 4—25 kV.A. TRANSFORMER PILLAR

with three single-core similar cables depending on the type of pole box used. The three-core cable connection is shown in Fig. 1, which illustrates the arrangements at Cardenbarns Farm, whilst the three single-core cable connection at Easter Balbegie Farm is shown in Fig. 4. At the latter place a sheet iron transformer pillar was employed. It, however, has now been given up in favour of the brickwork pillar. In both cases the capacity of the three-phase transformer is 25 kVA, and the supply pressure on the overhead lines is 12,000 volts; whilst the pressure on the low-

RURAL TRANSFORMER PILLARS AND KIOSKS

FIG. 5—TRANSFORMER PILLAR

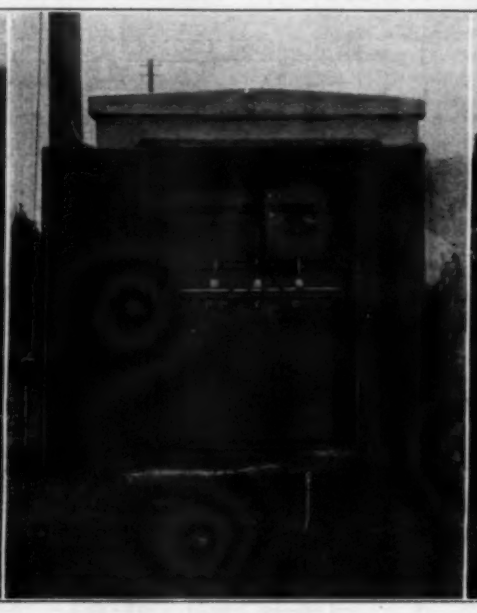


FIG. 6—PILLAR WITH DOORS OPEN

FIG. 7—PILLAR WITH ISOLATING SWITCHES

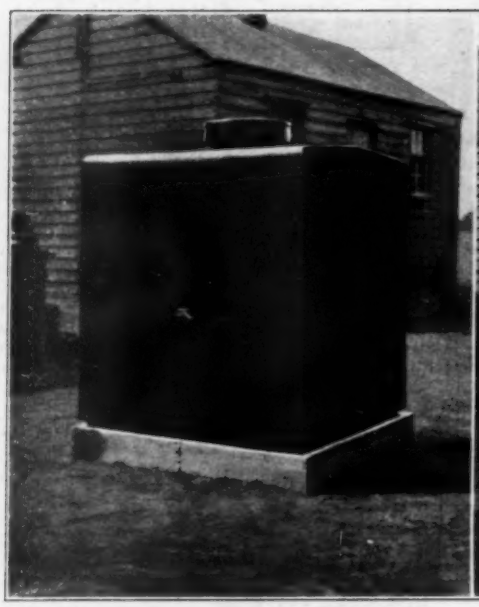


FIG. 8—12,000 TO 440/250 VOLT TRANSFORMER KIOSK

FIG. 9—75 kV.A. TRANSFORMER KIOSK

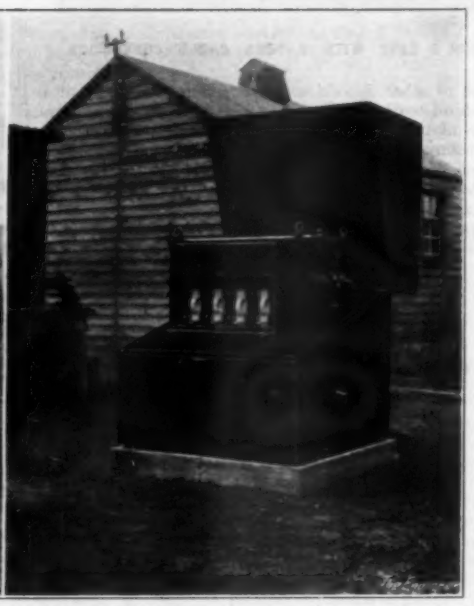


FIG. 10—75 kV.A. TRANSFORMER KIOSK

tension three-phase four-wire outgoing supply is 440/250 volts.. Outside isolating switches are used in both instances. An interesting feature of the equipment at the Easter Balbegie Farm is that the low-tension supply is conveyed by underground cables to the low-tension switch and fuse in a box fixed to a tree, which also carries the insulators for the low-pressure line, the farm end of which is also fixed to a tree, as shown in Fig. 12.

Reverting to the brick transformer pillars, from the cable end box in the pillar the current passes to bare copper rod bus-bars, mounted on barrel-type insulators, and between these bus-bars and the E.H.T. transformer terminals there are three Empire fuses, as shown in the drawings. These fuses are held in position by means of flexible copper braid, and the connections to the bus-bars are capable of being made at any point on the bus-bars to suit the transformer E.H.T. terminals. Where the high-tension supply is brought in by means of an underground cable, the isolating switches have to be placed inside the pillar, as shown in the drawing, Fig. 3. These isolating switches are protected by means of expanded metal screens and are fitted with operating rods, as shown in Fig. 11, the operating rods being efficiently connected to earth. The illustrations, Figs. 5, 6 and 7, show the application of these brick pillars to farm work.

When the supply is taken from an underground cable a tapping is taken from the cable into the transformer pillar or the main cable is looped into the pillar, the latter being the more usual arrangement. As isolating switches can only be safely operated after the cable has been made dead, they are not provided except at certain points where an oil-break switch is also installed.

The bus-bars are in short sections, and it is a simple matter to remove a length for the purpose of sectioning the cable for test purposes. In the case of branch lines or cables of, say, 0·0225 square inch section, it is considered that sufficient protection can be provided by oil switches or fuses at the points where they are tapped off the main cable.

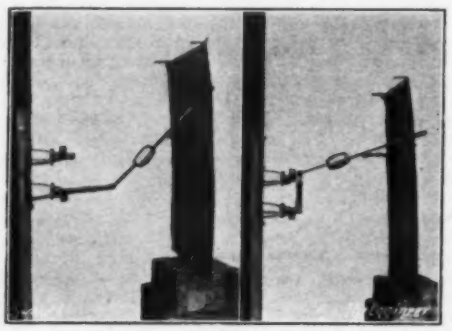


FIG. 11—ISOLATING SWITCH

The transformers are directly connected to the branch cables without any further protection, and the transformer then becomes part of the cable or line. Fuses are provided on the low-pressure side to control the outgoing low-tension cables.

Transformer kiosks of the type shown in Fig. 13 are also employed. This illustration shows a wayside transformer kiosk installed in a school playground, the incoming 3000-volt supply being brought to the transformer by means of an underground cable. The outgoing three-phase four-wire supply gives 440/250 volts. The cost of the complete equipment is £88. A larger kiosk of this type equipped with a 75-kW, 12,000-volt transformer, is shown in Fig. 8. Another view, with the kiosk opened, is given in Fig. 9, whilst Fig. 10 shows the cover of the low-tension fuse box removed. In order to avoid having to alter the E.H.T. and L.T. cable box connections in the event of it being necessary to install a transformer of different capacity, a standard transformer tank, for all capacities up to 75 kW., is employed. If it is necessary to change a transformer, the sheet iron cover, consisting of a lid and body, can be removed, and the E.H.T. cable and L.T. cable and distribution boxes can be unfastened without disturbing the cables in the ground. The transformer can then be drawn aside, the spare transformer can be put in its place, and the E.H.T. and L.T. cables can be connected up in a very short space of time.

On a slate panel in the low-tension fuse chamber three main fuse plugs are mounted, and there is also a street lighting fuse plug and a neutral link. In order to facilitate the examination or renewal of a main fuse without interruption of the supply, each fuse plug is provided with a spare set of contacts, connected in parallel with the contacts which normally grip the fuse, so that, with the aid of a spare fuse plug, the working fuses can be inspected and renewed without breaking the circuit. If necessary, the spare fuse plug can also be used for connecting an ammeter in the circuit, for the purpose of measuring the load on the transformer and for ascertaining whether the load on the various phases is properly balanced. The

three main fuses—one per phase—are connected to the three main cores of the five-core outgoing L.T. cable, whilst the neutral link is connected to the fourth core and the fourth fuse to the street lighting core of the cable. This fourth or street lighting fuse plug, with its auxiliary contacts, is arranged so that it can

FIG. 12—FARM END OF L.T. LINE

be connected to any of the three phases of the transformer in order to allow the village street lighting to be changed from one phase to another, so as to facilitate balancing the phases. After the E.H.T. distributor has been made dead, a transformer may readily be disconnected from the cable by removing a hand hole cover in the top of the transformer tank, and by moving three single-pole links in the tank to

FIG. 13—50 kV.A. WAYSIDE TRANSFORMER KIOSK

the off position. A 75-kW unit, complete with E.H.T. and low-tension cable boxes costs £168.

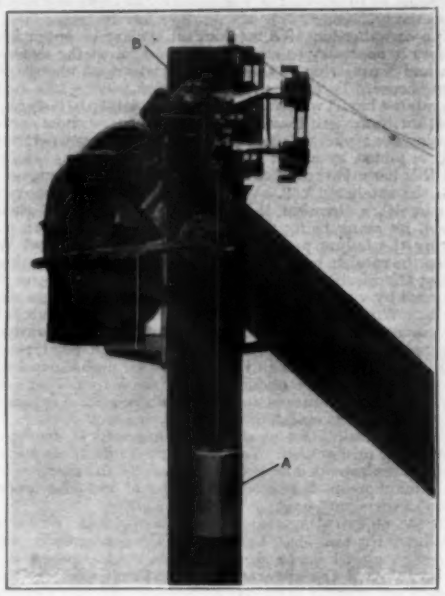
The revenue derived from farms in the Fife Electric Power Company's area of supply is quite appreciable, the sums collected during a year from five farms taken at random being £73 16s. 7d., £35 6s. 3d., £29 17s. 4d., £26 4s. 7d., and £26 4s. 7d. The average revenue from some sixty farms is £32 per annum per farm.

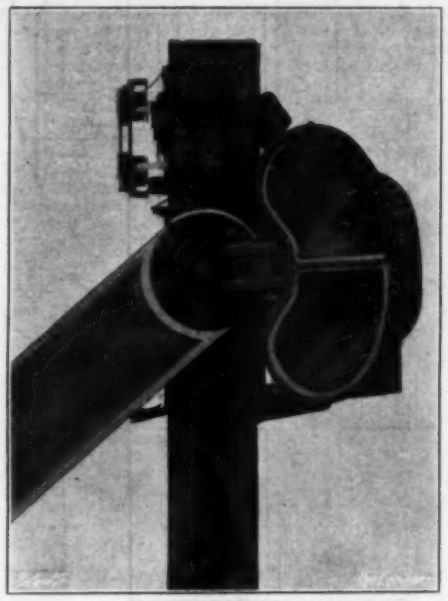
A New Method of Operating Semaphore Signals.

ALTHOUGH the system of operating semaphore signals which we are about to describe had its origin in very unusual circumstances—it was invented to meet and defeat the predatory habits of Chinese bandits—it should, we think, prove interesting and useful under a variety of normal conditions which will readily suggest themselves to railway signal engineers. The system is the invention of Mr. J. H. Williams, chief engineer of the Canton-Hankow Railway. Our readers will, no doubt, recall the description of another of Mr. Williams' inventions, an automatic surveying and profiling machine, which appeared in our issue of November 4th.

For many years Central China has been overrun by bandits and undisciplined soldiery, who have developed the habit of damaging or stealing any signal fittings, rods, wires, pulleys or other railway equipment which come within reach of their ability to destroy or remove. Apart from such wilful damage, the railway engineer in China is faced with the fact that his unfenced lines are used as highways by pedestrians, and that, as a consequence, ground fittings are open to a considerable measure of accidental damage. Various ways of surmounting these troubles have been tried. On one railway, the Kin-Han, the signal posts were enclosed in a species of stockade and the operating wires were run on poles at a height of 15ft. above the ground. This method was found expensive, and was unsatisfactory for other reasons.

The problem which Mr. Williams set himself to solve was governed by the fact that no power, other than





FIGS. 1 AND 2—WEIGHT-OPERATED ELECTRICALLY-CONTROLLED SEMAPHORE

manual, was available for the operation of the signals. Faced with this restriction, he had to devise a means of operating the signals without relying on groundwork of any description, and to do so without using anything other than the existing telegraph poles to carry the connections between the signal-boxes and the signals. At the same time it was most desirable that the dimensions of the wayside signal levers should be made as small as possible, in order that they could be placed within the station buildings under lock and key. To make the system effective against trespassers, it was realised that it would be necessary to cut off the lower portions of the signal post ladders and to provide the lamp lighter with a ladder which he could carry with him to and from the station.

The apparatus as set to work on the signal posts is illustrated in Figs. 1 and 2. The power required to operate the semaphore is derived from a weight A suspended by a rope from a drum B. Each time the semaphore is operated, the weight falls through a small height and at intervals it has to be re-wound. In the particular case illustrated, one winding was sufficient to last for seven days on a line over which six trains passed per day. No doubt in normal conditions, in which the lowest position reached by the weight would not be determined by the plundering propensities of the local population, the period between re-windings might be prolonged. The re-winding is performed, in the instance illustrated, by hand, but, as Mr. Williams fully realises, it might be accomplished from a distance by the use of electricity or compressed air or by hydraulic power. Alternatively, it might be effected continuously by means of a treadle worked by the passing trains.

The drum B, Fig. 3, is geared to a shaft C, at the end of which there is an arm carrying a crank pin D. This crank pin, as shown in the simplified diagram, Fig. 4, works in a slot in a frame E, which can rise and fall in a fixed guide frame F, the upward and downward movement of E being limited by the stops G G. The rising and falling frame E is joined by a connecting-rod to the semaphore. With the weight hanging, as shown in Fig. 1, it is clear that if it is allowed to fall it will cause the crank pin D to rotate in an anti-clockwise direction. The frame E would therefore be reciprocated vertically and the semaphore would rise and fall rythmically until the driving weight reached the limit of its descent. Means are provided to bring this rising and falling motion under control. These means are such that when certain electro-magnets are energised, the frame E is caused to make a complete movement in one direction and to stay in the position reached, thereby lowering the semaphore and keeping it lowered. When the magnets are energised a second time the frame E makes a complete movement in the reverse direction, thereby raising the semaphore and keeping it raised. The flow of current in the magnet coils is in the one direction for the two movements.

From Fig. 4 it will be gathered that the slot in which the crank pin D moves is not part of the frame E, as we have suggested above, but is really formed in an inner frame H which is capable of sliding vertically within the frame E. The motion of the frame H is communicated to the frame E by the pressure of the lug J against the short arm of a cranked lever K pivoted to the frame E. When, therefore, the crank pin rises from the position shown, the two slides will move upwards as if they were one, until the motion is stopped by the pin G striking the frame F.

The slide E is now at the top of its stroke and the semaphore is in the fully lowered, or "clear" position. When the semaphore has to be raised, a switch at the station or signal-box is closed, and an electro-magnet—see Fig. 3—lying in line with the lever K is momentarily energised. This magnet is carried on an extension of the movable frame E and operates an armature L, which forms a catch for the end of the lever K. When the magnet is energised, the lever K is unlatched and a spring behind it causes its long arm to fall and its short arm to move clear of the lug J.

The diameter of the circle in which the crank pin D moves is greater than the movement permitted to the frame E by the stops G. Were the two exactly the same, the crank pin would be at the centre of its slot when the frame E was at the top of its stroke, and there would be nothing to prevent the crank pin continuing beyond that

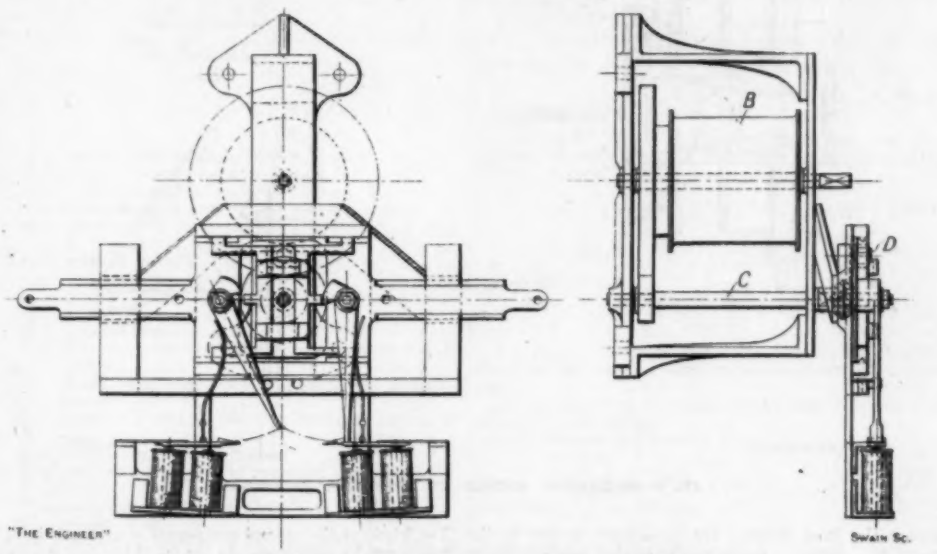


FIG. 3—THE WILLIAMS SEMAPHORE OPERATING MECHANISM

point under the driving force of the weight. As things are, the crank pin stops at some point to the right of the mid position, and holds the semaphore lowered so long as the lever K is latched up.

When this lever is unlatched by the energisation of the magnet, the crank pin can rise to the highest point of its circle, carrying the frame H with it. During this short

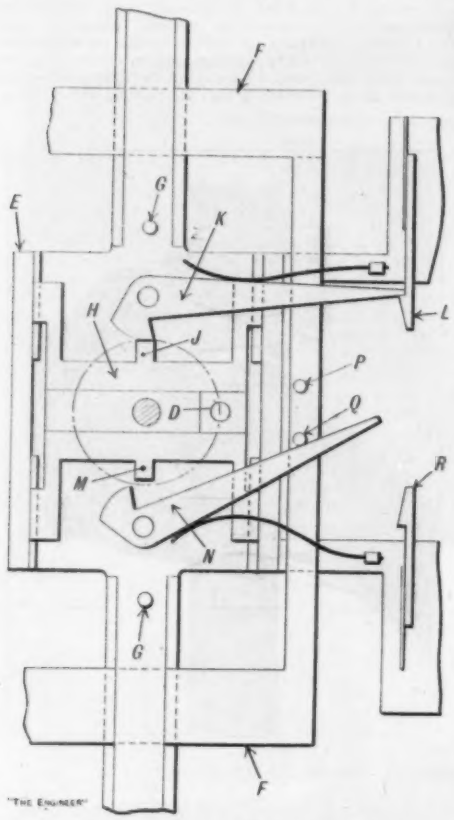


FIG. 4—DIAGRAM OF ESCAPEMENT

period, the frame H is free to slide relatively to the frame E, because the lever K is no longer effective. The crank, continuing its rotation past the highest point of its circle, now causes the frame H to descend. During the descent a second lug M bears against the short arm of a second lever N, which for the moment is in the latched position and not unlatched, as shown. The two frames H and E, therefore, descend as one, and come to rest when the lower stop G strikes the fixed frame. The semaphore is now in the raised or "danger" position, and farther rotation of the crank pin is stopped because, as before, it comes to rest short of the mid point of its slot.

During the descent of the two frames the long arm of the lever K bears against a stop P on the fixed frame F, with the result that its end moves upwards until it becomes relatched on the catch L.

The lever N is latched by a catch R, which is operated by a second electro-magnet in series with the first. When it is unlatched, it allows the crank pin to resume its rotation, with the result that the two frames H E are moved upwards and the semaphore is once again set to "clear." During the upward movement the lever N is re-latched, through the agency of a second pin Q on the fixed frame F.

The two electro-magnets are, as we have just said, connected in series. Consequently, each time the electric circuit is momentarily completed both are energised. Both the levers K N are therefore unlatched simultaneously each time the magnets are energised. Only one of them, however, will escape from its catch L or R. The other one will be held from escaping by the pin Q or P, and will be re-latched immediately the circuit is opened.

It will be gathered that the action of this escapement mechanism can be controlled from the station or signal-box by means of a single conductor, and that the repeated closing and opening of a single switch in the circuit alternately raises and lowers the semaphore.

If the signalling has to be performed without the aid of electricity, the mechanical system illustrated in Fig. 5 is adopted. The two catches K N are joined by chains to the end of a bar S set in line with the mid position of the sliding frames. The lengths of the chains are such that when the frames are in one or other of their extreme positions, one or other of the chains is taut and the other slack. A pull exerted on the bar S will be transmitted through the taut chain, with the result that the semaphore will be moved to the "danger" or the "clear" position, according as to whether it was formerly at clear or danger respectively.

The introduction of a mechanical system of operation renders it necessary to make provision against the expansion and contraction of the operating wire with change of temperature. To this end the operating wire is attached to a ratchet bar T, which is weighted sufficiently to keep the wire taut, however it may lengthen or shorten, without compressing the spring on the bar S. The signal lever pivoted at U is joined by a link to a lever pivoted at V. At its end this lever is provided with a pawl W, which engages with the ratchet bar T. When the signal lever is moved over in either direction, the lever V is depressed and then raised, its rising being assisted by the spring beneath it. During the falling portion of its movement, its pawl W forces the ratchet bar down. During the succeeding rising period the ratchet bar follows the upward movement of the pawl by virtue of the compression in the spring on the bar S. When the connecting wire expands, the ratchet bar moves past the pawl without disturbing the operative engagement. When the wire contracts the pawl rises with the ratchet bar until it is disengaged and allowed to fall through the space of one tooth by the action of a fixed stop X. By these means automatic compensation is made for changes in the length of the connecting wire.

Certain possibilities exist of this mechanical arrangement being mishandled. To obviate their effect, electrical contacts are provided at Y and Z, whereby the position of the semaphore is indicated by means of red and green lights in the signal-box.

In the electrical system of operation, similar contacts and lights are provided, but they would appear to be less necessary by virtue of the provisions made against the mishandling of the apparatus. The switch whereby the momentary current is caused to flow through the electro-magnets, is controlled by a lever one movement of which, in either direction, first makes and then breaks the circuit. In addition, once the lever has been moved to switch on the current, it cannot be moved back again until the first stroke has been completed. The first of these features is reproduced in the mechanical arrangement, as represented in Fig. 5, but there is nothing to prevent the lever being pushed half over and then returned. The effect of such incomplete working would be to reverse the indication of the semaphore corresponding with the position of the signal-box lever. The true position of the semaphore would, however, continue to be exhibited by the pilot lights.

In addition to the pilot lights, miniature signals repeat the position of the main semaphore to the signalman.

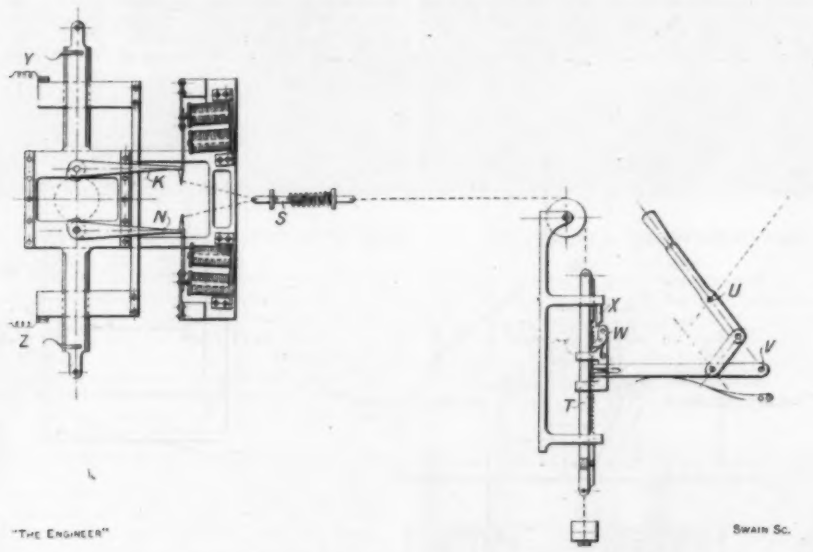


FIG. 5—MECHANICAL METHOD OF OPERATING ESCAPEMENT

The whole of the control equipment is enclosed in a box which can be locked up. In the lid of the box is a switch governing the current supplying the pilot lights. The arrangement is such that when the lid is opened to operate the semaphore, the pilot light switch is closed automatically and when the lid is closed the switch is opened.

IT is reported that a party of railway officials and others has recently visited Stranraer with a view to investigating the possibilities of building a deep-water pier at Kirkcolm on Loch Ryan, whereat Atlantic Liners may call to embark or disembark passengers, mails, and possibly cargo. It is not stated what steamers are to be affected by this interesting innovation, but presumably they are those centred on Glasgow, as that city can be reached in two hours from Stranraer and Carlisle in three hours, so that there might be many advantages for Scotland and the North of England in the scheme.

South African Engineering Notes.

Two-class Railway Omnibuses.

A NEW type of railway omnibus, specially constructed for service in the country districts, was tested in Cape Town recently. Two of these vehicles were built at the Salt River Railway Works, and will ply between Klaver and Calvinia, a distance of 92 miles. As deep ruts, sandy patches and large stones are some of the obstructions on country roads, the omnibuses have been designed for rough duty. The six massive wheels have patented "plastic" hubs, which are fitted to separate axle systems linked to a double set of springs. On running over obstructions the wheels bend sideways or lift upwards and pass on without the occupants really knowing that any unusual movement or jolting has taken place. These vehicles will be the first omnibuses to have separate first and third-class compartments. Seating for ten first-class passengers is provided in the front portion. The major part of the accommodation is given to the third-class. Upholstered bench seats skirting the sides of the omnibus will hold about thirty people. The central space will be utilised for baggage and produce. Extra baggage carriers have been built under the body of the omnibus. Wire-mesh windows afford ventilation to the third-class compartment. These windows are provided with canvas blinds. The engines are of Thornycroft's make and of 36 horse-power. A large petrol tank occupies a position in front of the steering wheel.

Nine Months' Mineral Production.

The September statistics recently issued by the Department of Mines and Industries shows that the value of the minerals produced during the first three-quarters of the present year had reached a total of £45,961,363, an increase, as compared with the total for the corresponding period of last year, of £2,932,181. Gold accounts for only £624,016 of this increase, the biggest increase being in diamonds, which, in the nine months, reached a total value of £9,615,390, an advance on the production of the corresponding period of last year of £2,167,762. Other increases are shown in platinum, copper, and the miscellaneous category, while decreases are shown in coal, silver, osmiridium and tin. The totals for the first three quarters of the present year were as follows:—Gold, £32,187,362; silver, £88,628; osmiridium, £41,896; platinum, £118,389; diamonds, £9,615,390; coal, £2,881,709; copper, £410,071; tin, £258,064; other minerals, £259,853. On the large gold mines there were employed during September an average of 197,344 coloured persons and 21,613 whites. On the diamond mines there were employed 17,135 coloured men and 3013 whites. On the alluvial diggings the number of whites dropped from 14,770 in August to 7889 in September.

Excessive Engine Repairs.

Complaints concerning the excessive repairs required by American engines, as compared with British, have been persistent for years past in the Union workshops, and apparently there is as much ground for them to-day as ever, if not more. About two years ago several American engines of the "Mountain" and "Pacific" class were put on the main line passenger traffic by way of experiment, and wonderful tales of their prowess were told by those responsible for ordering them. Heavier than any engines previously in service, one of them was stated to be able to bring a passenger train from Johannesburg to Cape Town, 956 miles, without being changed, and that was done on at least one occasion. It was then stated that such a result had never been achieved before, and that the time was also less than any previous record. That, however, was proved to be incorrect, as British engines, of Class "15 C," had accomplished the same feat on several occasions, when necessity demanded it, and in better running time, but no one had thought of advertising the fact. Since then others of these American engines have been purchased and their running, and especially their visits to the workshops, have been kept under observation. On November 1st the writer visited the Salt River Railway workshops and found two of the "Big Ben's" as they have been christened, in the repair shop, and no less than six others in the yard waiting their turn to come in. One engine, upon which extensive repairs were being started, was only put on the road in July, 1926. During the first year of service of the type on the main line two came in with broken castings, and one shortly after twelve months' running. It was stated in the repairing shop that compared with the British engines of the "15 C" class, the American engines cost twice as much in repairs, to say nothing of the time lost in the shops.

A Congress of Commerce.

The Congress of the Federated Chambers of Commerce of the British Empire was opened at Cape Town on October 4th and closed on October 7th. On October 10th the delegates left by special trains for a tour of the Union of South Africa and Rhodesia, which came to an end on November 4th. The delegates from overseas numbered over a hundred, and about forty ladies accompanied them. The most prominent men among them were Lord Kylsant, who is president of the Federation; Sir Edward Davson, Chairman of the Executive Committee; Sir Arthur Shirley Benn, Deputy Chairman; Sir James Martin, President, London Chamber of Commerce; Sir Park Goff, Sir Sydney Humphries, Sir Frederick G. Rice, and Colonel H. C. Woodcock. The Congress dealt with a large number of resolutions submitted by various Chambers of Commerce, and passed resolutions affirming its opinion that the restoration of penny postage at the earliest opportunity would be of material benefit; that quicker transit between Great Britain and the Dominions and Colonies was desirous for promoting inter-Imperial trade and communications generally; and that all the self-governing Dominions of the British Empire should contribute equitably and proportionately for the national naval defence. Resolutions in favour of Imperial preference, the development of inter-Imperial trade and many others of lesser importance were also submitted.

A New Form of Compressed Air Meter.*

By E. J. LASCHINGER.

For the last twenty years or so the author has been particularly interested in the subject of the measurement of flow of compressed air.

This problem seems to be quite simple, but I am sure that those who have studied the subject and who have experimented or have had practical experience with air meters will agree that the accurate measurement of compressed air is difficult—more difficult than measurement of liquids, such as water—and we have all had our experiences with regard to water meters.

Fortunately, scientific experimenters have given us a fairly accurate knowledge of the laws governing the behaviour and physical constants of compressible fluids, upon which we can base fairly accurate deductions and, in the mind's eye, visualise and measure invisible substances such as air.

The measurement of compressed air and the latent power it possesses is a very important matter from the practical and commercial standpoint, in view of the amount of power thus used, especially in mining operations, and its cost, which is high when compared with electric power for example.

On the mines of the Rand there must be about 300,000 H.P. of air compressing machinery installed and at work.

Owing to its generally harmless nature, air power is more wasted than any other kind, and, owing to its invisibility and to absence of noxious or dangerous effects, such as those of leakage of gas or electricity, it is difficult to discover or trace; or, if wastage is known to exist, it is generally neglected or left for a more convenient season to be rectified.

The various types of meters well known to the author may be briefly indicated as follows:—

1. The theoretically simple method of filling a vessel of known capacity with air and discharging it. This method is of value for test purposes, but not for commercial use if the air power is required to do work.

2. Displacement meters of the piston type. These generally waste power and give a lot of trouble in practical operation.

3. Displacement meters of the oscillating disc type. These have too much leakage or else stick.

4. Measurement by fixed orifices either of the venturi, formed or sharp-edged type. These are not accurate at low flows, because the flow varies as the square root of the pressure difference and they have, therefore, an awkward flow scale.

5. Pitot tube measurements. The same remarks apply as in 4.

6. Inferential meters of the vane or turbine type. These are unreliable due to variation in frictional resistance.

7. Measurement by differential orifice such as a disc or other form of obstruction of fixed weight floating vertically in a conical tube.

8. A piston of fixed weight moving up a cylinder and progressively uncovering small orifices in the walls of the cylinder. These give trouble in sticking, due to grit.

9. Meters of the gate type actuated by springs.

10. Meters of the weighted door type. In this type as heretofore constructed, the law of the relationship of gate movement to flow of air is complicated, and as generally constructed it is unreliable at or near its maximum capacity, and the percentage of error is greatest at the points where error represents the greatest amount in power passing through.

11. Measurement by means of heating the air passing, i.e., by passing electrical current through a rheostat fixed in a pipe and measuring the flow by difference in temperature between the inlet and outlet end. It may be remarked here that temperature or heat measurements are amongst the most elusive and difficult things to do with accuracy. It must also be pointed out that the heat (produced electrically) which causes the rise in temperature is entirely wasted, so that the operation of a meter is a source of constant cost. This may seem small, but a little calculation will show that this is not so in the case of large meters.

The problem presented itself to the author of obtaining a meter that would be suitable more especially for regular use underground, and after inquiries for meters from many manufacturers and after purchasing a number of different types and testing them, none was found suitable, and the only thing to be done was to design and make one. After considering all of the methods of measurement, the author, in conjunction with Messrs. W. H. G. Furnivaal and D. B. Maclaren, of the Rand Mines Air Testing Department, came to the conclusion that an air meter combining the two strong points of the gate and orifice types would be the best for the practical and commercial metering of compressed air—in effect the movement of a gate controlling a differential orifice in such a manner that the delicacy of movement of the gate at low flows should be combined with the relative accuracy of the orifice at high flows. In order to get a positive and reliable action it was realised that mechanical devices such as springs should be eliminated, and that the weight of the gate itself should be the controlling factor.

Numerous experiments were carried out on different designs and a meter was evolved which so far as essential parts is concerned is very simple.

The theory of the meter, which establishes the relation of the various factors, was to make equal angular movements correspond to equal increments of flow and may now be elaborated.

In Figs. 1 and 2 is illustrated what we shall call the shield type, the size of the orifice being dependent upon the distance between the trailing edge of the gate and the curved shield.

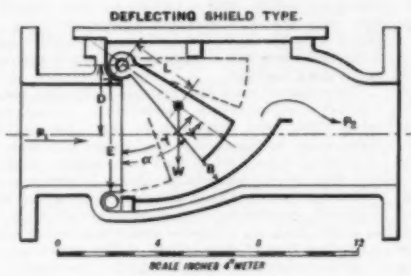


FIG. 1.

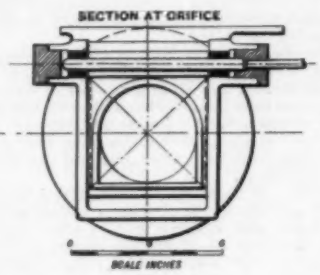
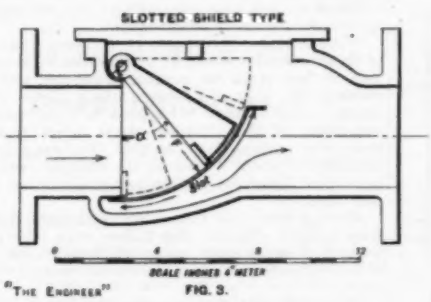


FIG. 2.



"THE ENGINEER" FIG. 3.

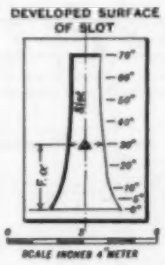


FIG. 4.

SWAIN SC.

THEORY OF F.M.L. FLOW RECORDER.

Symbols used for shield plate type. (See Figs. 1 and 2.)

α = angle of swing of gate in degrees.
β = angle of lead.
$\gamma = \alpha + \beta$.
a = area of orifice, square inches = B b.
b = uniform width of gate in inches.
c = coefficient of discharge.
g = acceleration of gravity, ft. sec. sec. = 32·1.
h = difference of pressure, front and back of gate, lb. per sq. in. = $p_1 - p_2$.
p_1 = pressure in front of gate, lb. sq. in.
p_2 = pressure behind gate, lb. sq. in.
A = area of gate exposed to differential pressure, sq. in.
B = span of orifice, inches.
D = distance, centre of pivot to middle of area A, in inches.
E = depth of gate exposed to differential pressure, inches.
L = distance centre of pivot to centre of gravity of gate.
Q = air flowing, lb. per sec.
R = gas constant = 53·46 average for Rand conditions.
T = temperature (absolute) = 461 + deg. Fah.
W = weight of gate, lb.

From the theory of flow of air through an orifice we have:

$$Q = a\,c\,\sqrt{\frac{2g}{R}}\sqrt{\frac{p_1}{T}}\sqrt{h} \quad . \quad . \quad . \quad (1)$$

From the theory of balance of couples

$$h\,A\,D = W\,L\sin\gamma \quad . \quad . \quad . \quad . \quad (2)$$

Therefore

$$\sqrt{h} = \sqrt{\frac{W\,L}{A\,D}}\sqrt{\sin\gamma} \quad . \quad . \quad (3)$$

Combining (1) and (3):

$$Q = a\,c\sqrt{\frac{2g\,W\,L\,p_1}{R\,A\,D\,T}}\sqrt{\sin\gamma} \quad . \quad (4)$$

$$\text{Let } K = \sqrt{\frac{2g\,W\,L\,p_1}{R\,A\,D\,T}} \quad . \quad . \quad . \quad , \quad (5)$$

$$\text{Then } a = \frac{Q}{c\,K\sqrt{\sin\gamma}} \quad . \quad . \quad . \quad . \quad (6)$$

Now, from the condition that the angle of movement of the gate shall be proportionate to the rate of flow,

$$Q = J\,a \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

in which J is a constant determined by allocating to a certain maximum flow a maximum movement, i.e.,

$$J = \frac{Q\ \text{max.}}{a\ \text{max.}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Combining equations (6) and (7),

$$a = \frac{J\,a}{c\,K\sqrt{\sin\gamma}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Therefore B, the span of the orifice for any particular angle of movement of the gate, is

$$B = \frac{J\,a}{b\,c\,K\sqrt{\sin\gamma}} \quad . \quad . \quad . \quad . \quad . \quad (10)$$

From this equation (10 the dimensions of the opening are determined, as all the factors on the right-hand side of the equation are known for any particular case, except the coefficient, c, which is fairly constant and may be assumed at, say, c = 0.8. It can, however, be determined exactly only by experiment. It is known to increase slightly with an increase in the area a.

In Figs. 1 and 2 is represented a scale drawing of a 4in. meter as constructed for a maximum flow of 100 lb. air per minute (1600 c.f.) at an initial pressure of 90 lb. per square inch gauge for Rand conditions—mean temperature 70 deg. Fah. and maximum movement of the gate of 70 deg. of arc. The gate weighs 8·34 lb. and the angle of lead (β) is 13 deg. maximum drop of pressure across orifice 0·387 lb. per square inch, or 10·7in. of water and a differential pressure 2.43in. of water to open the gate at minimum flow.

The other form of gate and differential orifice is illustrated in Figs. 3 and 4, which we call the slotted plate type. The shield is circular in shape, conforming to the movement of the trailing edge of the gate, the air passing through a formed slot.

The theory governing the size of the slot is given as follows:—

Symbols used in theory of slotted plate gate meter—these are the same as in the former case, except that we introduce the symbols

F = distance from centre of pivot to edge of gate, inches.
Δ = width of slot at any particular angle of opening.

In this case, however, the measurement of angles (so far as the mathematics are concerned) is in terms of arc to radius unity.

We have again:

$$a = \frac{Q}{c\,K\sqrt{\sin\gamma}} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$$\text{and also } Q = J_1\,a \quad . \quad . \quad . \quad . \quad . \quad (11)$$

Therefore

$$a = \frac{J_1\,a}{c\,K\sqrt{\sin\gamma}} \quad . \quad . \quad . \quad . \quad . \quad (12)$$

Differentiating, we have:

$$d\,a = \frac{J_1}{c\,K}\,d\,\frac{a}{\sqrt{\sin\gamma}} \quad . \quad . \quad . \quad . \quad (13)$$

From the forms

$$d\,\frac{x}{y} = \frac{y\,d\,x - x\,d\,y}{y^2} \quad . \quad . \quad . \quad . \quad (14)$$

and

$$d\sqrt{y} = \frac{d\,y}{2\sqrt{y}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

we obtain

$$d\,a = \frac{J_1}{2\,c\,K\sqrt{\sin\gamma}}\,(2\,d\,a - a\cot\gamma\,d\,\gamma) \quad . \quad (16)$$

since $\gamma = (\alpha + \beta)$ and β is constant

$$d\,\gamma = d\,a \quad . \quad . \quad . \quad . \quad . \quad (17)$$

From Fig. 4 we see that

$$a = \int \Delta\,d\,F\,a, \text{ so that } d\,a = \Delta\,F\,d\,a \quad . \quad (18)$$

Combining equations (16), 17), and (18) we obtain

$$\Delta = \frac{J_1}{2\,c\,F\,K\sqrt{\sin\gamma}}\left\{2 - a\cot\gamma\right\} \quad . \quad (19)$$

Converting, so that a is expressed in degrees instead of radians for convenience in using ordinary trigonometrical tables, we have

$$\Delta = \frac{J_1}{2\,c\,F\,K\sqrt{\sin\gamma}}\left\{2 - \frac{\pi}{180}\,a\cot\gamma\right\} \quad (20)$$

$$\text{and } J_1 = \frac{180}{\pi}\,\frac{Q\ \text{max.}}{a\ \text{max.}} \quad . \quad . \quad . \quad . \quad . \quad (21)$$

and as before

$$K = \sqrt{\frac{2g\,W\,L\,p_1}{R\,A\,D\,T}} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Fig. 4 gives the theoretical shape of a slot in a 4in. meter for the same conditions as the shield plate meter Fig. 1.

The coefficient of discharge in this case is about 0·63, but also varies slightly.

It will be seen that when $a = 0$

$$\Delta = \frac{J_1}{c\,F\,K\sqrt{\sin\beta}} \quad . \quad . \quad . \quad . \quad (22)$$

and when $\gamma = 90$ deg.

$$\Delta = \frac{J_1}{c\,F\,K} \quad . \quad . \quad . \quad . \quad . \quad (23)$$

The meters designed on the above principles were intended primarily as distribution meters for the mines of the Central Mining—Rand Mines group of the Witwatersrand goldfields, in order to assess distribution of air to various services or sections of the mines under that administration.

The desiderata in the type of meter required are:—

(1) Reasonable accuracy over the whole range of measurement.

(2) Robust design to withstand rough handling and the air concussions due to blasting underground.

(3) Simplicity and few parts.

(4) As well as being an indicator of momentary flow it must give a graphic flow time record so that a picture of the whole day's happenings is available for examination and for comparison with the operations or work done by the air in the section measured.

(5) Reliability in continuous operations so that it is not

* Paper presented at the Empire Mining and Metallurgical Congress, Vancouver, B.C., September 14th, 1927.

easily choked by air carrying water, oil and a certain amount of dust, &c.

(6) It must not have perishable parts, such as rubber or leather, or depend for its operation on floats in mercury, oil or water. Devices such as springs are also to be avoided.

(7) It must not be sluggish and when no air is passing should automatically and instantly indicate zero.

(8) It should require little attention and have a long life and give a minimum of trouble; in short, it must be dependable.

After much experimental work, testing and experience gained by practical use underground the type preferred is of the design shown in Fig. 1.

The following is a commercial description of the meter called the F.M.L. graphic recorder.

Fig. 5 gives a longitudinal sectional view of the essential meter parts in one form of construction.

In the body of the main casting A a door or gate B of substantial weight hangs vertically over the pipe opening. Below the lower horizontal lip of the gate is a brass shield

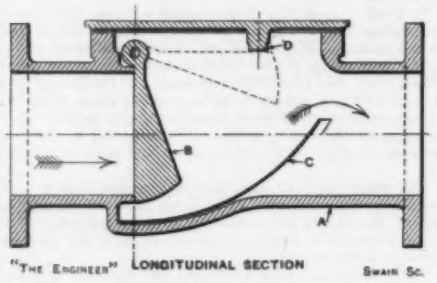


FIG 5.—F.M.L. AIR METER

C fairly close to the lip when the gate is shut, but progressively further away as the gate opens further owing to increasing flow of air. The result of this arrangement is to make the angular movement of the gate correspond to the rate of flow so that equal increments of angular movement of the gate represent exactly equal movements of flow over the whole range.

A pointer attached to the outer end of the spindle of the gate would therefore indicate the rate of flow marked in equal divisions on a graduated arc.

In the meter as built, however, the pointer is not rigidly connected to the gate spindle, but the movement is transmitted by an arm to a cam which moves on a separate spindle. On the top of the cam is fitted an arm carrying a pointer and a pen. The pointer indicates rate of flow on an equally divided scale and the pen marks a continuous record on a chart which is wrapped round a clock drum in the usual way. Attached to the bottom and side of the cam is a dampening vane working in oil contained in a strong box. This box also protects the outside moving mechanism from injury and from being tampered with.

The chart is easily changed without risk of damage to the pointer or pen by removing the clock by unscrewing one thumb nut, taking off the used chart, putting on a new one and replacing the clock. The size of the chart has been standardised at 12in. long by 5in. wide so as to give a reasonably sized diagram for inspection.

The clock, pointer, pen and indicating scale are covered by a hinged casing with a glass front. This box can be locked up, the meter attendant and some responsible official only having the keys. The glass front is provided so that the miner or responsible official can at any time see how much air is being taken, and the record for a few hours previously, and also note the reading of the pressure gauge. A small electric light is provided inside the casing. A spherical level is fixed to the top plate of the meter to check the true level setting of the instrument.

The meters are calibrated for a standard pressure and temperature, which are the normal for the conditions obtaining. A correcting chart is provided to convert any other pressure or temperature to the normal basis. These corrections are generally small. Automatic devices to correct these variations introduce too many complications, having in view the object of the meter.

The meter indicates to within plus or minus 1 per cent. over a range from full capacity to one-twentieth of full load. The meters are designed for a maximum drop of 1 lb. per square inch at full load. All parts are of gunmetal or brass to minimise corrosion due either to air or water. The main body of the casting is tested to 200 lb. per square inch pressure to disclose any defects.

Fig. 6 is the reproduction of a chart showing a portion of a record taken in a mine on a working shift. The clock was fixed so that the usual one-hour interval represents only one minute. Two drilling machines were at work. The heavy horizontal lines represent the time of actual drilling of each machine. It will be noticed that there was trouble with one of the drill bits from 9.16 to 9.22 a.m., and this is reflected in the graphic record of the recorder, whereas from 9.07 to 9.11 a.m., when both machines were working properly, the record gives a fairly smooth line. On the Rand Mines air is measured by pounds instead of cubic feet.

The outstanding advantage of the uniform scale of flow is that a planimeter may be run over the record and the total and the average rate of air consumption over any period can be obtained. With distorted scales which are common to most recording meters this cannot be done.

In one mine which has been fully equipped with these recorders on all levels and sections (altogether about thirty meters of various sizes) the sum total of the readings of these meters over a month has agreed to within 2 per cent. to 6 per cent. with the air sent underground as measured in bulk at the surface. The capacity of the compressing plant in this case is 40,000 cubic feet air per minute. It is therefore fairly obvious that these meters conform to the desiderata enumerated previously.

It is also to be noted that the path of the air through the meter is direct, *i.e.*, it does not cause the air to turn round sharp corners as in the case of many meters. One effect of this is very little loss of pressure through friction, and the other important practical advantage of not being easily fouled or choked. Dirt and small stones, &c., are simply blown through.

As to reliability and dependability, it may be mentioned that several of the first experimental recorders have been in constant use underground for two years, and when brought back to the test plant for examination and test were found not to have altered, but were simply cleaned up and sent back again.

There are at present about 300 of these meters in use in these fields.

One point to be remembered, however, is that, in the Central Mining—Rand Mines group, most of the mines use air from the Victoria Falls and Transvaal Power Company, which is generated by turbo-compressors and is therefore of a non-pulsating flow. The use of these meters in places where there are violent pulsations is not to be recommended, unless means are introduced for dampening down excessive variations.

This question of measuring air with pulsating flow is most difficult. It has been investigated both theoretically and experimentally, and quite a number of technical and scientific papers have been written within the last few years, but so far as the author is aware nothing final has been evolved. The practical difficulties have not been overcome, although various devices are, and can be, used to minimise the effects.

It is known to those who have studied the problem that there are two kinds of waves, which we may call pressure waves and velocity waves; the former travel with the velocity of sound and are governed by the same law, but the velocity waves, which form a real pulsating flow, present the greatest problem and cause very queer

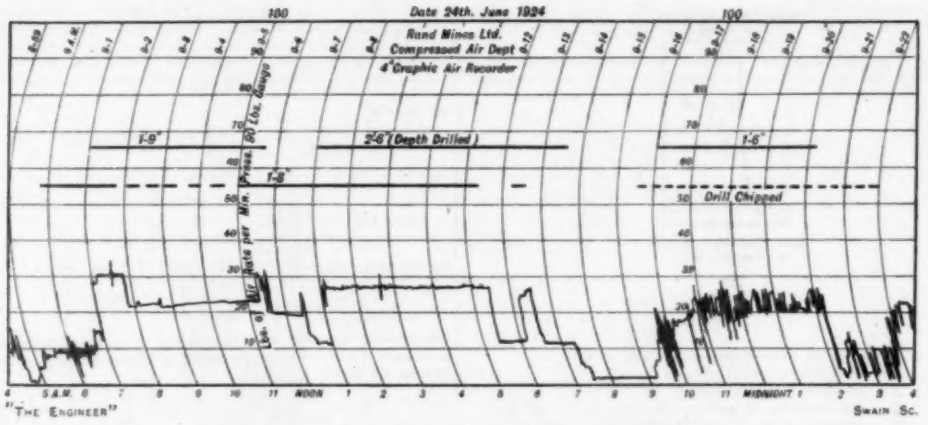


FIG. 6—AUTOGRAPHIC RECORD FROM F.M.L. METER

phenomena, especially in manometer measurements.

It is known that these effects can be minimised by introducing capacities and constrictions in the air transmission mains by receivers, enlargements, orifices and other devices which will absorb the kinetic energy of the waves.

The author and his colleagues are at present experimenting on certain lines in order to discover some cheap and effective method of dampening down, if not eliminating, pulsating effects, so that some device can be attached to any kind of air meter in order that reliable registration may be obtained in all cases.

A meter operating on the shunt principle has also been evolved and is being used with success on three mines on the reef for measuring main outputs of compressor stations. In such a meter an orifice is inserted in a large pipe and a small sensitive recorder on the gate principle is inserted in a small pipe connecting the two sides of the orifice.

By establishing the relations between the main flow and the shunted flow (similar to the principle upon which most electricity meters are built) the small meter diagram can be graduated to read the total flow.

This meter is suitable as a large station meter and the cost is very moderate. It also has the advantage, as proved by actual trial, of automatically dampening down the pulsation effects of the main flow as affecting the shunt flow, *i.e.*, the pulsations on the recording mechanism are very small compared with the pulsations in the main pipe.

In conclusion, the author would remark that the measurement of compressed air to the various services and sections of the mine is a most important item in checking waste, and in all cases economies are effected. A good many mine managers and engineers have had quite a shock when the result of air measurements were brought to their notice for the first time. It is, however, necessary to keep continuous records, not merely taking readings at spasmodic intervals.

Water meters constructed on the same principle have been designed, constructed and put into operation and have so far given every satisfaction. These meters have been equipped with integrating gear in addition to the chart record, and are particularly useful as station output meters. The charts show the slightest variation in pump output due to variations in periodicity of electric power supply. The largest size constructed is for a 16in. main with a maximum capacity of 2500 gallons per minute with a pressure drop of 1 lb. per square inch. This meter measures with accuracy a flow down to 40 gallons per minute.

Factors of Safety and Quality of Material.*

By W. H. RIDDLESWORTH, M.Sc., M.Eng.

THE introduction of special steels having an elastic limit considerably higher than that for ordinary mild steel, affords a reason for a re-examination of two questions in connection with structural design.

What do we mean by factor of safety? What are the most desirable strength properties in the materials used?

It is not the purpose of this paper to attempt to fix a value for the factor of safety, but rather to indicate some of the considerations which should govern its magnitude, to relate it to the appropriate strength property of the material, and to afford some guidance towards a proper choice of the materials available.

A factor of safety—called by the cynic, with some degree of truth, a factor of ignorance—is, it will be admitted, the ratio of the stress at which failure would take place to the working stress. But what is failure? It is not necessarily actual fracture, for many a forging and many a casting would be condemned were there any permanent distortion after it had been tested to twice the working load; many a bridge would be counted a failure did it deflect more than a specified fraction of its span under working load, and many a machine tool would be an utter failure were there any measurable distortion under working conditions. Many a bulkhead would fail were the deflection to exceed some unknown but comparatively small amount sufficient to produce leakage.

There are at least two criteria of failure, namely, actual rupture and excessive distortion. Actual rupture is a gross thing, and there can be but little doubt about its occurrence or otherwise. Excessive distortion is a matter of definition, and what may be excessive distortion in one case may be negligible in another. In many cases excessive distortion may be taken to be one from which the structure does not completely recover on removal of the load, whilst in other cases an excessive distortion is one which exceeds some function of dimensions of the structure.

It is surely true to say that the forging which just passes the test—*ante*—has a factor of safety of 2, that the bridge which just shows the specified deflection under the working load, together with the bulkhead which has been stiffened up and supported until it will just hold in water, have each a factor of safety equal to unity.

With ordinary structures of ordinary materials, none of these examples would be near failure by actual rupture, and all too often we confuse ourselves and others by stating, *e.g.*, that the forging has a factor of safety of about 5, just because it happens to be stressed to about two-fifths of the ultimate stress when under test to twice the working load, or that the bridge has a factor of safety of about 5 because the induced stress when the permitted deflection is obtained is about one-fifth of the ultimate.

Having seen that failure requires some definition, we may turn to consider that failure may take place under normal working loads, under abnormal loads, or because of lack of uniformity or of premature decay in the material used.

It may be said that a factor of safety proper provides against the first contingency, and a factor of ignorance against the others, but unfortunately in many cases the stresses due to working conditions cannot be determined with precision, and again we have to call in the aid of the factor of ignorance.

Quite a small factor of safety provides ample security against failure under working loads when the stresses can be predicted with accuracy, but some sort of evalution of probabilities has to be made in an endeavour to provide against uncertain working stresses, abnormal loads, decay, &c.

The practice of using a larger factor of safety for gear liable to abnormal loads—such as hoisting gear—than for more structural supports, and of using a larger factor of safety for timber structures than for steel, show how this evaluation has proceeded.

In past experience factors of safety have been fixed with regard to ultimate strength alone, but with the advent of new materials it behoves us to examine the foundations on which that experience has been built, and it may very well be that suitable factors of safety for such materials will only be acquired as the result of much

TABLE I.

Type of part.	Mode of failure.		
	Fracture	Distortion.	
		Permanent set limit.	Dimensional limit.
Tension member	U	Y	E
Compression member, short	U	Y	E
,, ,, long	E	Y & E	E
Shear member	U	Y	N
Beam	U	Y	E

Where U = Ultimate stress.
Y = Elastic limit stress.
E and N are moduli of elasticity.

experience and many trials and errors. One fully reported

* Institution of Engineers and Shipbuilders in Scotland, December 20th, 1927.

failure would do more to establish a basis than scores of structures which do not fail.

An attempt is made in Table I. to indicate the peculiar strength quality or property of the material upon which failure depends, for each elementary structural part and for each mode of failure,

If the criterion of failure be rupture, ultimate strength is the important property ; if it be distortion, then modulus of elasticity and elastic limit stress come in order of importance.

In long compression members and in beams where distribution of material is of importance, it should be noted that a specified distortion limit is not sufficient for determination of the required scantlings ; a limit must also be set upon the induced stresses, which may be referred to either the ultimate or the elastic limit stress.

The material strength qualities of a number of steels now on the market are given in Table II., and certain deductions drawn therefrom.

TABLE II.

	Mild steel ship.	High tensile steel. Admiralty.	High elastic limit steel. Martin.	High elastic limit steel. Service.
U tons per sq. inch ..	30	35	32·5	37·3
Y tons per sq. inch ..	8	14	16·5	24·6
E lb. per sq. inch ..	30×10^6	30×10^6	$1{\cdot}08 \times 30 \times 10^6$	$30{\cdot}3 \times 10^6$

Ultimate and elastic limit stresses vary widely, but the modulus of elasticity is practically the same for all. Variations of about 4 per cent. occur in samples from the same melt.

In cases where there is merely a dimensional limit to the deflection, one quality of material is as good as any other. Where there is a permanent set limit, the qualities range themselves in order of elastic limit stress, whilst for simple rupture they range in order of ultimate stress.

For many structures it is not known exactly what form failure really takes. Consider the case of the structure of a ship. Are we to anticipate failure by actual fracture or by excessive distortion ? Probably the latter, for most of the fractures heard of are merely local affairs due generally to discontinuities. It appears probable that the particular distortion to be guarded against has a dimensional limit, so that material with a high value of E is desirable, together with an elastic limit high enough to avoid permanent set when the permissible distortion has been reached.

Past experience has been based upon a factor of safety on the ultimate strength, as if the failure to be guarded against were actual fracture, and the practice of allowing higher calculated stresses in larger ships indicates, *inter alia*, that the method of stress calculation is not completely satisfactory. A dimensional correction appears to be called for.

Any rational consideration of the question of using high elastic limit, high tensile, or other steel in ship construction involves the solution of the problems of the form of failure to be anticipated, and of the factor of ignorance to be applied to cover the unknown errors of the method of stress or deflection calculation now in use.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Christmas Holidays.

VERY little thought has been given to business by industrialists in the Midlands this week. Practically the whole of the iron and steel and manufacturing works in the Midlands and Staffordshire have been idle during the whole of this week, though a few mills and foundries started at mid-week. The Christmas break has provided a very welcome respite in many sections of local industry, and next week business will be resumed with better heart. The prospects for the heavy industries in this area are slowly improving, and the next seven days will be utilised chiefly in clearing the deck for the 1928 action. It is realised that the fight will be a hard one, but manufacturers are determined to leave nothing to chance, and, given freedom from black labour clouds and storms, they feel convinced they will emerge from the combat with better balance sheets than have been produced this year. Most things are favourable for an early revival in trade, and though there was only a poor attendance at the weekly meeting of the Midland iron trade in Birmingham to-day —Thursday—those present were practically unanimous in the brightness of their views. They circulated inquiries for bulk supplies in the New Year, and made small purchases for current needs. The transactions which took place were on the basis of recently quoted rates, and the attitude adopted by producers of iron and steel led one to the conclusion that quotations are not likely to vary much from their present level for some little time to come. Consumers, many of whom, it is said, have substantial contracts to place, are hoping for easier values at the January quarterly meeting ; at any rate, they are content to wait until then before giving out their business. Next week's meeting should give some indication as to what may be expected from the first quarterly gathering of the year 1928.

Steel Business.

Business in steel is of a very restricted character at the moment, there being no qualms as to future supplies and few fears of advances in price. The position is very different from that which faced steel consumers twelve months ago. Supplies were short, and values were advancing, while no guarantee as to delivery at early dates was to be obtained. What is wanted just now is a freer placing of engineering contracts so that engineers may better gauge their requirements. This, in turn, would result in larger tonnages being ordered from the steel works, and do away to some extent with the roll-changing which has been the bugbear of the steel trade for the past few months, causing as it does more expensive production than is usual when normal tonnages of material are the subject of the orders on the books. There should be a good call for most, if not all, classes of steel as soon as the engineering establishments resume work. Steel sheets for making up stampings and motor requirements will be wanted almost at once, while firms devoted to the manufacture of oil drums and cans, packing kegs, &c., are none too well supplied with material. Railway contracts will call for considerable material and various Birmingham industries connected with shipbuilding should also prove good customers. Special steels for tool making have been in good demand for some time, and the call for these gives every prospect of continuing. Structural engineers in this area have a fair amount of work on hand, and prospects of new contracts are good. Steel is much cheaper to obtain than it was a year ago, there having been a fall of from 20s. to 25s. per ton in structural materials during the twelve months. Angles and joists, which are to-day quoted £7 12s. 6d., were making £8 12s. 6d. to £8 17s. 6d. when the year came in. Small rolled bars now £7 17s. 6d. were then £8 15s. to £9. Structural plates, which can now be delivered within seven days or even less, were at this time last year unprocurable. Not only is the price situation much better, but at the moment foreign competition, owing to the threatened German strike, is considerably less keen. Though the strike has so far not materialised, and many authorities believe that it will not take place, the effect of the threat has been to raise the values of imported steel, billets being quoted £5 7s. 6d., finished steel bars £6, and No. 3 Belgian iron £5 18s. 6d. Unfortunately, rather large quantities of German steel are still coming in on old contracts for the production of gas and steam tubes and to meet the requirements for light strip for the motor trade.

Staffordshire Iron.

Staffordshire makers of finished iron are finishing the year in a hopeful mood. They are benefiting not only from shipbuilding demands, but also from railway requirements. During the past month makers of marked bars have added to already fairly well-filled order books some additional good lines to meet locomotive requirements. The Black Country chain and anchor and cable industries are better off for work than they have been for a considerable period, and their demands on the Staffordshire ironmaster next year should be considerable. Very little business is passing in Crown quality iron, in which department values range from £9 5s. to £10 5s., the latter being the Staffordshire makers' quotation. Trade in nut and bolt iron and fencing bars is likewise quiet, but here the competition comes from abroad. While local mills will not accept business below £9 per ton, Belgian mills are prepared to deliver into the Black Country at £5 18s. 6d. Practically all the business consequently goes abroad, and the reductions in prices made during the year by Staffordshire makers, aggregating £2 5s. to £2 10s. per ton, have failed materially to increase their sales. One of the most lively departments of the iron trade is that dealing with iron tube strip. Tube makers have been constantly calling for good supplies, which are now available at £11 10s., as compared with £15 at the beginning of the year. The reaction in favour of wrought iron for tubes on account of its superior rust-resisting qualities has made much progress during the past twelve months, and it is intended to carry further next year the enterprise which has been largely responsible for the recovery of its popularity.

Galvanised Sheets.

Galvanised sheets have had a fairly steady run of business during the year, but the trade is finishing up with poor order books, the past few weeks having witnessed a falling off in demand, both from home and overseas buyers. Efforts to stimulate demand by lowering prices have met with little success so far, but inquiries are said to be encouraging and the outlook hopeful. Values of 24 gauge corrugated sheets, which now stand at £13 to £13 2s. 6d., are considerably below those of December last. In that month sheets were making £16 5s. per ton, and the mills had an abundance of orders.

Tin-plates.

The improvement in the tin-plate trade is maintained, and more interest is now being shown in the course of business in the Birmingham area. Moderate orders have this week been taken for unassorted lots at 18s. 9d. to 19s.

Pig Iron.

There has been little business in pig iron this week to test the market value, but quotations have not receded further. This week's market brought forth a few small orders, but an ample sufficiency of supplies in the New Year being taken for granted, users await January before placing substantial forward contracts. Smelters remind them that pig iron prices are now down to 1913 level, and that further concessions are not possible. They repeat their threat further to reduce output in preference to accepting lower and unremunerative prices. Foreign supplies now offer no advantage to Midland consumers, and some good business should be done in the immediate future. Derbyshire No. 3 foundry iron was to-day quoted £3 5s. upwards, and forge £2 19s., while Northampton foundry was named £3 upwards and forge £2 14s. per ton at furnaces. North Staffordshire iron was offered at £3 4s. 6d., a figure unusually low. If repeated next week, it is likely to attract substantial business. Birmingham founders have not large stocks, and should be coming on to the market early next year. The best customers at the moment are the light casters, but their orders are for small tonnages. Forgemen who can only see a few weeks ahead remain poor purchasers. This department has been under a cloud for some considerable time, and prospects of an early recovery in this branch of the industry are not considered bright. Producers are not without hope, however.

Derbyshire and Coal Control Scheme.

Derbyshire coalowners at a private meeting on the 23rd inst. discussed the proposals for regulating the output and price of coal from Yorkshire, Derbyshire and Nottinghamshire pits, to which I referred at length in my last week's letter. The result of the meeting was not made public, but it is understood that while some owners are in favour of adopting the scheme, they are not by any means unanimous, and further deliberations will be necessary before an agreed policy is decided upon.

Cannock Coalowners and Engine Winders.

The Cannock Chase coalowners and the Cannock Chase and Pelsall colliery engine winders have approved a new agreement respecting wages and other matters which is to take effect for four years from January 1st next to December 31st, 1931, and thereafter until terminated by three months' notice on either side. Under the agreement the rate of pay for winders is fixed at 11s. 9d. a day. The week is to consist of seven days. The men are to receive one week's holiday per annum, with pay, after twelve months' service, provided the other winding enginemen agree to relieve each other during the period of holiday. The usual privileges are to be continued. It is interesting to note that the agreement will last twelve months beyond the period set for the duration of the agreement entered into at the end of last year between the Cannock Chase coalowners and the Cannock Chase and Pelsall miners' unions.

Motor Chassis Contract.

Maudslay Motors, Ltd., Coventry, has received an order from the Great Western Railway Company for forty-six 32-seater motor omnibus chassis.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Port Extensions.

AUTHORITY to borrow a further £4,000,000 is being sought by the Mersey Docks and Harbour Board, and for that purpose a Bill is to be introduced into Parliament during the coming session. Of this sum £2,500,000 is to be applied to the completion of works under existing powers, the remaining £1,500,000 being employed "for the purposes of carrying out works in connection with the improvement and the better maintaining and preserving of the Port of Liverpool and the sea channels leading thereto and the navigation of the river Mersey." A start has been made by the London, Midland and Scottish Railway Company on the dock improvement and extension scheme at Fleetwood, the cost of which is estimated at about £100,000. Expenditure will be chiefly in connection with the widening by 30ft. of the stages occupied for the display of fish after landing ; the extended stages will be 100ft. wide and about 2000ft. long. This extension will necessitate the removal of several lines of railway metals.

Improvement in Constructional Engineering.

An improvement in the financial results of the year's operations of Edward Wood and Co., Ltd., constructional engineers, Manchester, seems to be foreshadowed in the announcement by the directors of a dividend of 5 per cent. per annum on the preference shares and an interim dividend of 4 per cent. per annum on the ordinary shares for the half-year ended November 30th. It is five years since the company last declared an interim dividend on the ordinary shares. The company has recently secured several important contracts for the supply and erection of steel work in various parts of the country, the total quantity involved being in the neighbourhood of 20,000 tons. Among the principal orders were the following :—The Lancashire Electric Power Company for steel work for the super-power station at Kearsley ; steel structures for the Chemical and Metallurgical Corporation, Ltd., London and Runcorn ; steel work for Messrs. Macintoshes' cable factory at Derby ; and steel work for the new Wesleyan Hall at Portsmouth.

Business Announcement.

It is officially announced that the Pearson and Knowles Coal and Iron Company, Ltd., Warrington, has disposed of the whole of its controlling share interest in the business of Burnell and Co., Ltd., galvanised sheet manufacturers, Ellesmere Port, Cheshire. Sir Peter Rylands, who represented the Pearson and Knowles Company, and was also chairman of Burnell and Co., has resigned his seat on the board.

Engineering Employers' Association.

The members of the Manchester District Engineering Employers' Association have elected Mr. H. Pilling, of Galloways, Ltd., President, Mr. Leonard F. Massey, of B. and S. Massey, Ltd., vice-president ; and Alderman F. J. West, of West's Gas Improvement Company, Ltd., treasurer for the ensuing year.

Non-ferrous Metals.

Fairly free offerings of tin and evidence of a further addition to stocks of the metal in this country have been bearish factors in this section of the non-ferrous metals market, although the actual loss in values has not by any means been important. The demand for the metal has, of course, been affected by the seasonal quietness, but the market seems to be looking for better conditions during the next few months compared with those ruling of late, not only in the United States and on the Continent, but also in this country. Similar hopeful views are being taken in connection with the copper situation, and in the closing days of last week a fair amount of buying support was forthcoming. On balance, values in this section have advanced fairly substantially in the case of standard brands, both for prompt and forward, whilst refined descriptions have been fully maintained. A slight advance has been registered in lead, although buying

interest has been on a limited scale. There has been comparatively little business stirring also in the case of spelter, but prices have been steady and show little change on balance compared with the previous week.

Iron and Steel.

The iron and steel markets opened after the Christmas break in a very quiet mood, and buying has been on a very poor scale. In the case of foundry iron the price situation seems to be lacking in strength, more particularly in respect of Midland varieties of pig iron. Sellers are anticipating, however, an improvement in forward buying early in January, and, if that takes place, on an appreciable scale, it should have a steadying influence on the market. Meanwhile, values of all descriptions are not quotably changed since last report. This applies, also, to manufactured iron, the demand for which at the moment is exceedingly slow. With regard to home-manufactured steel there appears to be little immediate hope of any departure from the hand-to-mouth buying policy which consumers have so persistently pursued during the past six months or so, although a fair aggregate trade is looked for in the new year. Here, again, quotations are about maintained at last week's level. Apart from a further slight stiffening in quotations for continental steel bars, which now range from £6 to £6 2s. 6d. per ton, delivered to works in this district, there has been little alteration in the price of imported steel, the demand for which—both for semis and finished materials—is very poor at the moment.

BARROW-IN-FURNESS.

Hematite.

There is practically nothing being done in the hematite pig iron market this week owing to the holidays. Production is being restricted, but, despite that, stocks are not being reduced except at works where the whole of the furnaces are out. Carnforth, Ulverston, Askem and Cleator Moor are idle, the total number of furnaces in blast being eleven. Such orders as are held are small in comparison with the state of things which obtained at the beginning of the year. All buyers are keeping down the tonnage of their orders to immediate requirements, and there are other customers who are noticeable for their absence from orders books in this district. Competition is very keen, and only very low prices tempt purchasers. The iron ore trade is only moderate, as can be expected in view of several furnaces being idle. There is a little more activity among the Cumberland mines, but it does not amount to much. The steel works at Barrow are stopped for the holidays, but will be going next week, and orders are held which will keep them active for a time in the rail, merchant and Siemens departments. The hoop mills are assured of a steady run.

Holidays at the Vickers' Works.

The holidays at Vickers' Naval Construction Works were short, and men were back at work on Wednesday morning. This is a sign that there is plenty of work for the hands, and that there must be as little delay as possible. The outlook for Vickers at Barrow is distinctly brighter than a year ago.

SHEFFIELD.

(From our own Correspondent.)

A Broken Week.

ONLY about half-time has been worked at the majority of establishments in Sheffield and district this week, and in some cases operations have been entirely suspended. Owing to the holidays, little fresh business has been placed, and there is therefore nothing new to report about the actual situation. The pig iron and billet departments are very quiet, and the open-hearth steel trade is in the most unsatisfactory position of all. Conditions are much better on the manufactured side than on that which deals with bulk steel, but even there the situation leaves much to be desired. Specifications for railway axles, tires and springs have recently been on an increased scale, and the revival in shipbuilding encourages hopes of improvement on both the heavy and light sides of the steel industry. There has been an improving demand for tools during the present month, and the falling tendency in that trade is believed to have come to an end. On the whole, there is a good deal of confidence that trade will improve in the New Year, although it is not expected that much advance will be seen in the first month.

Railway Orders.

Among the orders recently placed for railway rolling stock are two received by local firms. Cravens Railway Carriage and Wagon Company, Ltd., of Sheffield, has received a contract to build two private saloons for the Rhodesian Railways; and the Leeds Forge Company, Ltd.—a subsidiary of Cammell Laird, and Co., Ltd., Sheffield—is to build five all-steel Pullman type *de luxe* saloon coaches for the Vascongados Railway of Spain. The London and North-Eastern Railway Company announces a large building programme of engines and wagons for next year. The works at Doncaster have not received any intimation as to their share, but it is understood that they will be employed up to full capacity throughout the year.

A Bar Iron Tragedy.

If some branches of the steel trade are in an unsatisfactory state, the situation of the bar iron trade is still worse. Several firms in Sheffield and district are engaged in the manufacture of this material, but for years they have found themselves faced with difficulties in the form of foreign competition, the use of steel instead of bar iron, and other troubles. Now one of the oldest firms—S. H. Burrows and Sons, Ltd., of the South Yorkshire Ironworks, Attercliffe—has permanently closed. About 400 men and boys are thrown out of employment. The firm was established in 1866 by the late Mr. S. H. Burrows, and its iron soon gained a reputation for its quality among users in many parts of the country. The directors state that they have been carrying on at a loss during the past few years, hoping that trade would gradually recover, but the prospects of such recovery are now so remote that they have decided to cease operations rather than incur further losses on manufacturing.

An Improved Report.

In view of the conditions which prevailed during the first half of the working year the report of the United Strip and Bar Mills, Ltd., of the Ickles, Sheffield, for the twelve months ended June last, may be described as encouraging. True, it records a trading loss of £1721, but this figure is small compaed with that of the previous year, which was no less than £29,602. The directors state that during the first half of the year the mills were unable to operate owing to the coal stoppage. Manufacturing operations were resumed last January in favourable conditions, from the point of view of work in hand. If allowance be made for the effect of the coal stoppage, the output of the company's mills has shown a steady increase since the commencement of operations, thus showing that the company is gradually establishing markets for its products. It is, however, open to the keenest continental competition.

Great North Road Improvement.

The improvement and widening of the Great North Road, which is being carried out at a cost of £100,000 has just been advanced another stage by the completion of a by-pass road, nearly a mile in length, at Foston. The work is being executed by the Kesteven County Council, at the expense of the Ministry of Transport. The new by-pass road cuts out the village of Foston on the west side, and avoids a very awkward corner in the middle of the village. It has been constructed through a number of fields, is perfectly straight, and is built upon an 8in. concrete foundation. Altogether, about 10 miles of road between Grantham and Newark have now been dealt with. Much of the work has consisted of the strengthening of weak portions of the highway, the laying of a good surface of asphalt, the insertion of a 3in. concrete kerb on either side, and the construction of a permanent footpath on the north-east side, in addition to which the whole length of the road has been widened to the Ministry's regulation measurement of 20ft., increasing to 25ft. through the villages. A high and steep embankment on the long Newark hill has been made secure by the building of retaining walls on both sides to an average height of 8ft. or 9ft. In order to eliminate a blind corner at the top of Gonerby hill, the road has been diverted a distance of 40ft. westwards. In connection with this improvement, a number of houses had to be demolished and rebuilt. Mr. W. B. Purser, surveyor to the Kesteven County Council, has supervised the carrying out of the scheme, with Mr. R. Aitken as resident engineer.

A £350,000 Sugar Factory.

The contract for the erection of a beet sugar factory at Brigg has been placed with the firm of Stewart and Partners, Ltd., of London, Belfast and Dublin, at a figure of over £350,000. Preliminary work has already been begun on the site, and the actual construction will be started early in the New Year. It is expected that the factory will be completed in time for the 1928 crop. The designers are Hallesche Machinenfabrik, of Halle, Saxony who have built more than 200 sugar factories in various parts of the world. In accordance with Government regulations, not less than 75 per cent. of the machinery will be manufactured in this country. The factory will be capable of slicing 1000 tons of beet in twenty-four hours, and during the working season, from October to January, will be able to cope with the produce of 12,000 acres of land.

Economical Sewerage Scheme.

The adoption of the principle of gravitation instead of pumping in a sewerage scheme at Nether Langwith, Mansfield, has resulted in a saving of £10,000 in capital expenditure and £900 in annual maintenance costs. The scheme has been carried out jointly by the Bolsover Urban Council, and the Blackwell and Workshop Rural Councils, to meet developments in the Langwith area, where a new colliery village and a housing scheme have sprung up, and it is designed to serve a future population of 6500. Originally, a scheme was considered for which the lowest tender amounted to £24,011, but Mr. A. H. Elliott, surveyor to the Blackwell Council, propounded an alternative plan by which a hill was avoided, and this has been carried out at a cost of £14,062. Mr. Elliott was the engineer of the scheme, and the contractors were Adam Eastwood and Sons, of Workshop. At the official opening of the works last week, Dr. J. E. Wilson, medical officer for Mansfield, said that the effluent seemed to be extremely good, and complimented the engineer on the skill and resource he had displayed.

Coal in North Lincolnshire.

It is believed that good seams of coal exist in the Isle of Axholme, in North Lincolnshire, where a number of test holes were put down a few years ago. Further explorations are now in prospect, and during the last few days boring machinery has arrived on a site midway between Sandtoft and Epworth. It is understood that well-known Durham colliery companies are interested in the enterprise.

Waterworks Items.

The annual report on the Bradford Corporation water undertaking for the year ended August 31st shows a profit of £20,058, as compared with £5646 the previous year. The waterworks engineer, Mr. Lewis Mitchell, states that there is no likelihood of Bradford at any time being compelled to depend upon chemical processes of sterilisation for the protection and purification of its water supply. The not infrequent presence of certain bacteriological organisms, however, in water drawn from the Thornton Moor and Barden reservoirs is disquieting, and emphasises the necessity for more efficient control of the watersheds, which can only be rendered possible by their acquisition. The first water supply for the city was drawn eighty years ago from lands at East Manywells, which have now been acquired by the Corporation, and from which a good supply is again to be secured. Mr. Mitchell mentions that when this scheme is completed, it will permit the present Chellow Dean reservoirs, which are liable to serious contamination, to be discarded for water supply purposes, and will also enable the postponement of the costly work of duplicating the syphons of the Nidd aqueduct. The long-standing water problem of Mexborough is within a short distance of solution. Subject to certain small conditions, the Ministry of Health is in agreement with the water scheme of the local Council, and it has also sanctioned that body's application to lay pipes from the Ludwell springs to the existing waterworks pending settlement of details of the scheme.

NORTH OF ENGLAND.

(From our own Correspondent.)

A Brighter Outlook.

ALTHOUGH the year closes with a subdued inquiry for pig iron and steel, the condition of the industry in the North of England is much more healthy than it has been for some two years or more, and it is confidently believed that the New Year will witness a further expansion of the output and an approach to a wider measure of activity. Already there are signs that the outlook is brightening a little, a most encouraging feature being the continued tendency to buy forward. The position which has arisen in the German iron and steel trade on the question of hours and wages is being eagerly watched by manufacturers in this area. An impression prevails that a strike will be avoided, but, even if that is so, the establishment of the three-shift system in the German industry would inevitably raise the production costs in that country, and therefore react favourably on the British market.

Cleveland Iron Trade.

As is usual during the festive season, business is suspended in the Cleveland pig iron trade, but quite a hopeful feeling prevails and considerable market activity in the New Year is rather confidently anticipated. The statistical state of the trade is stronger than for some time past, and as output is insufficient fully to cover requirements, stocks promise to continue to decrease. Only thirty-nine of the 100 odd blast-furnaces are in operation, but their output is very satisfactory. In normal times the production of this district is 3,000,000 tons per annum, or about one-third of the make of the country. For the present year the production is estimated at 2,300,000 tons, as compared with 813,000 tons in 1926. It is estimated that during the present year 2,600,000 tons of ironstone have been taken from the Cleveland mines, as compared with 976,000 tons in 1926. Last year pig iron producing and ironstone winning plants were laid idle for many months owing to the coal stoppage. Values of Cleveland pig iron are steady and appear more likely to stiffen than otherwise. Sales to Scotland are still being made at about 1s. 3d. per ton below rates ruling for other business. Makers' fixed home and export prices stand at:—No. 1 foundry, 67s. 6d.; No. 3 G.M.B., 65s.; No. 4 foundry, 64s.; and No. 4 forge, 63s. 6d.

Hematite Pig Iron.

The East Coast hematite pig iron trade is steadier. Recently sales to both home and foreign buyers have been on an improved scale, and stocks are being drawn upon to meet requirements. The increased output which will come on to the market early in the New Year promises to be well taken up. While consumers claim that they can purchase on the basis of mixed numbers at 70s., makers ask up to 71s.

Ironmaking Materials.

Beyond sales of odd cargoes business in foreign ore is at a standstill. Best Rubio is nominally maintained at 21s. 6d. c.i.f. Tees. Durham blast-furnace coke is still slow of sale. Good average qualities are in the neighbourhood of 17s. 6d. delivered at the works.

Manufactured Iron and Steel.

Conditions vary in the manufactured iron and steel trade. One large steelworks on Tees-side continued operations without a break during Christmastide, two or three confined the holdiays to two days, and others are closed down for a week. An encouraging piece of news is the booking of orders by Pease and Partners Ltd., for 15,000 tons of steel rails and 24,000 tons of castings for the Dominions. The orders have been secured in face of keen foreign competition. Generally, however, business rules on quiet lines. The action of many of the continental steel manufacturers in withdrawing from the market in view of the possible stoppage at works has stiffened prices of foreign steel, and has afforded an opportunity to producers here to open out to some extent negotiations with customers abroad, who for some time past have been buying comparatively cheap foreign material; but as yet this district has not, so far as is ascertainable, derived any material benefit from the movement. Quotations are unaltered.

The Coal Trade.

There is nothing of special interest in the Northern coal trade. One of the largest of the Pelaw Main group of pits, expected to be closed indefinitely, will, it is announced, be reopened early in January, and the full number of men will be reinstated. Many other mines are in an uncertain position owing to difficulties with the working arrangements, but generally it is fully anticipated that amicable settlements will be come to, and that the New Year will see no further increase in the number of pits idle. For Northumberland steam coals the position

is steady up to the end of the first week in January, but for later the tone is dull and prices vary according to position. Best qualities are put at 13s. 6d. to 14s., and secondary qualities are 12s. 9d. to 13s. The trade in steam smalls is irregular, but fairly steady prices are being recorded. In gas coals the demand is steadily sustained at 15s. 6d. to 16s. for best kinds and 13s. 6d. to 14s. for seconds. There is only a moderate demand for coke, though production is being well cleared. Gas coke, is nominally steady at 22s. to 23s.; patent oven at 16s. 6d. to 18s.; and beehive and other specials 24s. to 30s.

SCOTLAND.

(From our own Correspondent.)

Holiday Influences.

THE approach of the New Year holidays has been apparent in the steel, iron and coal markets throughout the past week. With few exceptions, business has dwindled away, and there has been an almost entire absence of the rush usually experienced in normal times just before the holidays.

Steel.

It has been stated that one or two steel producers have received larger specifications than have been usual for some considerable time, but on the whole the demand for heavy steel has not improved to any extent, and the capacity of the mills is not taxed. The position of steel sheets has not altered. Heavy and light sheets, especially the former, are quiet, and prices for export are easy.

Iron.

The bar iron trade continues dull. The bar iron and re-rolled steel bar departments both require fresh orders, the present production being well below the capacity of the works in action. Home prices are unchanged, but export can on occasion be done below the nominal quotations of £8 per ton for bar iron and £7 per ton for re-rolled steel bars.

Pig Iron.

The state of the pig iron market is most unsatisfactory. Stocks in makers' yards are ample, and in view of this fact and the low level of prices, some of the thirty-one furnaces at present in action are likely to be blown out at the end of the year.

Exports and Imports.

Imports touched a very low level last week, the total not exceeding 2470 tons, made up of 220 tons of iron ore from abroad, and 2250 tons of iron from continental and English ports. Exports of iron and steel products amounted approximately to 5200 tons, and, in addition, considerable quantities of machinery and structural machinery were dispatched.

Power for Glasgow Tramways.

The Tramways Committee of Glasgow Corporation during the week agreed to recommend the installation of new electrical plant in Pinkston power station at an estimated cost of £237,500. It was further recommended that the Town Clerk should make application to the Electricity Commissioners for consent to the installation of plant in excess of the existing plant to be replaced, and that the manager should be instructed to obtain offers for the following items:—A new 18,750-kW turbo-alternator and six new boilers, for 50,000 lb. of steam per hour for Pinkston power station; high-tension switchgear and necessary alterations to buildings; and additional rotary converters in the Dalhousie, Coplawhill, Partick and Bellahouston sub-stations.

Coal.

During the past week business has been almost at a standstill, owing to restricted outputs and the covering of sales by shippers. Only odd lots have been available, apart from offerings of single nuts. Shippers with commitments for January are holding off meantime, and present quotations do not appeal to foreign buyers; consequently, fresh business is practically absent. The home market also shows little sign of activity, and in no department is there any indication of a desire to anticipate requirements.

Anthracite Coal.

Proposals to improve the export business have recently been considered by producers of anthracite coal in Scotland, and it is understood that negotiations are now proceeding whereby sales for export will be undertaken by one firm. It may be stated that the production of anthracite in Scotland is only about 2 per cent. of the total Scottish coal output.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade—1927.

THE Christmas holidays came as a welcome respite to all concerned in the coal export trade. The past year has provided scarcely a single feature that can be looked back upon with feelings of satisfaction. It has been a disastrous period for the colliery owners; business has been restricted and almost unremunerative for exporters, and low wages and extremely irregular employment has ruled for the workers at the pits. Market values of practically all classes of coals have persistently fallen throughout the whole of the twelve months. When the year opened best large steams stood at 27s. 6d. and best bunker smalls at 17s. per ton, whereas December finds the former standing at round about 19s. 3d. and the latter at about 12s. 6d. Other grades have declined in the same proportion. Those exporters who bought supplies of coal for delivery over the year have, of course, had to face losses, and owing to the difficult position in which many of them have been placed the majority of them have not by any means taken out their full quantities, and it is estimated that arrears of contracts run to fully 30 to 40 per cent. of the total quantity contracted for. Great efforts have been made to recover the markets abroad, following upon the disastrous national coal stoppage of 1926, and these endeavours have in a measure been successful, but it has not been a profitable business. The return of the eight-hour day at the mines has been responsible for a material increase in output per person employed, but with continental coalfields producing on a greater scale the competition for the trade available has been of a fierce description, and falling prices have been the cause of a progressive loss on the working of the mines. In the case of this district this loss for the three months ended October last represented an average of 1s. 3½d. per ton. In a large number of cases the loss was much in excess of this average figure. During the year unemployment was very bad, and at varying periods there were anything from 20,000 to 50,000 men out of work. Whereas in 1924 there were 492 pits engaged, employing 220,200 wage earners, and in 1925 476 pits employing 199,000 wage earners, an official statement showed that at the middle of November last there were 467 pits producing coal in this district and employing about 179,500 wage earners. Yet it is estimated that the total production of South Wales for the current year will turn out approximately at 48½ million tons, which compares with an output of round about 45½ million tons for 1925 and with 56,830,000 tons for the record year of 1913. Comparison with 1926 is, of course, of no value, as owing to the national coal stoppage, which lasted seven months, the total output for that year was only 20,450,100 tons. As regards shipments of coal, foreign and coastwise, bunkers, patent fuel, and coke, it is estimated that the total for 1927 will amount to about 29,783,000 tons, which compares with 12,156,407 tons for 1926, 27,868,466 tons for 1925, 32,947,650 tons for 1924, and with 41,378,178 tons for 1913.

Italy and German Coals.

Disturbing news was received last week to the effect that the Italian Government had entered into an agreement with Germany under the provisions of the Dawes plan for a great increase as from January of Italian imports of German coal to be paid for out of reparation credits. It was stated that this increase might amount to at least 100,000 tons per month. So far the report has not been confirmed, but the seriousness of such a possibility is shown by the fact that the South Wales Coal Exporters' Association has taken up the matter with the Government. It is interesting to recall that in 1913 exports of coal to Italy from the United Kingdom amounted to round about 9,647,000 tons, of which 5,565,000 tons were drawn from the Bristol Channel area. For the current year it is estimated that Italy's imports from the United Kingdom will amount to about 6,936,000 tons, of which 3,263,000 tons is the contribution of South Wales. There has therefore been a substantial falling off as compared with 1913, but in the case of Germany the position is very different, as the returns show that, whereas in 1913 exports of German coals to Italy came to only 892,000 tons, the quantity for 1927 is estimated to amount to 4,600,000 tons.

Coal Stabilisation Scheme.

The announcement was made on Thursday in last week that the committee appointed to deal with the details connected with the formation of the South Wales Coal Marketing Association had finally settled the scheme and had decided to issue it to the colliery companies on Wednesday of this week. On Thursday, January 5th, there is to be a meeting of the coalowners to consider the scheme and receive a report of the committee. It is stated that the scheme is to be submitted to the non-associated as well as the associated collieries. Before the scheme can be put into operation it will be essential to obtain the definite support of a very large majority of the collieries. What the percentage of support is to be has not been disclosed. If the scheme is adopted it will be governed by a deed of association and membership will be binding for one year. No disclosure has been made as to what the minimum prices are to be, but it is rumoured that they are on the basis of 20s. for best Admiralty large.

Coalfield Wages.

The independent chairman of the South Wales Coal Conciliation Board, Sir Francis Taylor, visited Cardiff on Wednesday last to hear the arguments of the coalowners and the representatives of the workmen concerning the claim and counter claim for the revision of the rates of wages in the coalfield. The decision of the independent chairman is expected to be received in the course of the next week.

French Coal Restrictions.

News has been received that the French Government has notified in the *Journel Officiel* the abrogation of the decree of May last, under which the system of licensing and restricting imports of coal into France came into operation. The removal of the barrier to imports takes effect as from January 1st, which was the expected date.

Current Business.

Operations on the coal market were reduced to a minimum immediately before the holidays, and there is likely to be very little activity until next week. There was something in the nature of a rush for coals at the last minute, and about the middle of last week there were actually steamers waiting to get into berth, but by the end of the week the clearance of tonnage was very substantial, as the return from all the ports on Saturday was that there were forty-five idle tipping appliances. It is expected that there will be a good supply of tonnage as the result of fresh arrivals of vessels over the holidays. The Coal and Shipping Exchange was closed on Monday and Tuesday of this week, work being resumed at the collieries and on the docks on Wednesday. The rumour is current that two of the French railways, the Paris and Orleans and the Paris, Lyons and Mediterranean Railways, have contracted for part, at any rate, of their requirements of coal over 1928.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

ELLISTON, EVANS AND JACKSON, Ltd., ask us to announce that they have removed their offices from 13, Cross-street, E.C. 2, to 93, Old-street, London, E.C. 1. Telephone as before, namely, Clerkenwell 1924 and 1925.

MERE AND MCLELLAN ask us to announce that on and after January 1st, 1928, their address will be Carliol House, Newcastle-upon-Tyne. Their telephone numbers and telegraphic address will remain unchanged, namely, Central 6361 and Amber, Newcastle-upon-Tyne respectively.

CONTRACTS.

THE BRITISH POWER RAILWAY SIGNAL COMPANY, Ltd., has received from the South Yorkshire Joint Line Committee an order to supply and install mechanical signalling appliances at Harworth Colliery.

THE GENERAL ELECTRIC COMPANY, Ltd., of Magnet House, Kingsway, London, W.C. 2, has received from the London Underground Railways an order for self-ventilated railway motor and "multiple-unit" type control equipment. The present order, which follows upon a series of orders for similar equipment already in progress of execution for this railway, covers 382 railway motors, type WT. 54, each rated at 240 B.H.P. on the one-hour rating, and "all-electric" automatic acceleration, multiple control equipment for sixty-three motor coaches and 107 trailer cars.

THE GREAT WESTERN RAILWAY COMPANY officially announces that the following contracts have been placed:—(*a*) Supply of forty-six 32-seater motor omnibus chassis, Maudslay Motors, Ltd., 64–70, Vauxhall Bridge-road, S.W. 1; (*b*) supply, delivery and erection of three 3-ton movable hydraulic cranes for Roath Dock, Cardiff, the East Ferry-road Engineering Works, Company, Ltd., Millwall, E.; (*c*) overhaul of steam hopper barges, Viscount Churchill and No. 8, Harris Brothers, Ltd., Swansea; (*d*) overhaul of tug St. Baruch, Barry Graving Dock Company, Ltd., Barry; (*e*) overhaul of the ss. Smeaton, Thomas Diamond and Co., Ltd., Cardiff; (*f*) supply of four 1-ton transporter cranes for Newport, High-street, Goods Station, Herbert Morris, Ltd., Loughborough; (*g*) supply of spare parts for new coal hoists and hydraulic cranes, Sir W. G. Armstrong, Whitworth and Co., Ltd., Newcastle-on-Tyne; the Hydraulic Engineering Company, Ltd., Chester; the East Ferry-road Engineering Works Company, Ltd., Gloucester; and Stothert and Pitt, Ltd., Bath; (*h*) supply of two double railway wheel lathes for Swindon locomotive works, Sir W. G. Armstrong, Whitworth and Co., Ltd., Ashton-road, Openshaw, Manchester; (*i*) supply of 12-ton fixed hand cranes for Portland, Oxford and Newbury, Messrs. Holt and Willetts, Cradley Heath; and (*j*) construction of a bridge near Nantgarw halt, Mr. Henry Smith, 55, Fields-road, Newport.

LAUNCHES AND TRIAL TRIPS.

BINTA, motor vessel; built by Sir W. G. Armstrong, Whitworth and Co., Ltd., to the order of Mr. Per Gjerding, of Bergen; dimensions, 408ft. by 54ft. 9in. by 32ft. Engines, single-acting, two-cycle, six-cylinder Polar Diesel; constructed by the Atlas Diesel Company, Ltd.; launch, December 8th.

CITY OF CANBERRA, steamer; built by William Gray and Co., Ltd., to the order of the Ellerman Lines, Ltd.; dimensions, 453ft. by 57ft. 9in. by 34ft. 6in.; 10,800 tons deadweight. Engines, reciprocating balanced quadruple expansion, inverted, direct-acting, surface condensing, 25½in., 37½in., 54in., and 78in. diameter by 54in. stroke, pressure 265 lb.; constructed by the builders; trial trip, December 9th.

DART, motor tug; built by James Pollock, Sons and Co., Ltd.; dimensions, 50ft. by 13ft. by 6ft. Engine, 120 B.H.P. Bolinder heavy oil, direct reversible marine; constructed by the builders; trial trip, December 9th.

SIDI AISSA, single-screw steamer; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Société Générale de Transports Maritimes à Vapeur, of Marseilles; dimensions, 340ft. by 43ft. beam. Engines, triple-expansion; constructed by the builders; launch, December 9th.

PACIFIC PIONEER, twin-screw motor vessel; built by the Blythswood Shipbuilding Company, Ltd., to the order of the Gulf Line, Ltd.; dimensions, 450ft. by 60ft. by 42ft. Engines, twin sets of single-acting Diesel engines; constructed by John G. Kincaid and Co., Ltd.; launch, December 10th.

KING EDWIN, motor cargo vessel; built by Harland and Wolff, Ltd., to the order of the King Line, Ltd.; dimensions, 400ft. by 54ft. 6in. by 34ft. 8in.; 4536 gross tonnage. Engines, six-cylinder, four-cycle, single-acting Diesel; constructed by the builders; trial trip, December 20th.

ULLAPOOL, steamer; built by William Gray and Co., Ltd., to the order of The Pool Shipping Company, Ltd.; dimensions, 418ft. by 53ft. 6in. by 29ft. 5½in. Engines, triple-expansion, 26in., 43in., 71in. diameter by 48in. stroke, pressure 180 lb.; constructed by the builders; trial trip, December 20th.

ALICIA, twin-screw tank steamer; built by Sir W. G. Armstrong, Whitworth and Co., Ltd., to the order of the Anglo-Saxon Petroleum Company, Ltd.; dimensions, 305ft. by 50ft. by 15ft. Engines, direct-acting, triple-expansion, 13in., 22in., 35in. diameter by 24in. stroke, pressure 180 lb.; constructed by Shields Engineering and Dry Dock Company, Ltd.; launch, December 22nd.

KING LUD, motor vessel; built by Harland and Wolff, Ltd., to the order of the King Line, Ltd.; dimensions, 400ft. by 54ft. 6in. by 34ft. 8in.; 5180 gross tonnage. Engines, six-cylinder, four-cycle, single-acting Diesel; constructed by the builders; launch, December 22nd.

WHITWORTH SOCIETY.—The fifth annual commemoration dinner of the Whitworth Society was held on Wednesday, December 21st, 1927, being the anniversary of the birth of Sir Joseph Whitworth, Bart. The chair was taken by the President, Mr. T. Sugden, M. Inst. C.E., &c., and sixty-six members were present. Interesting notes upon the life of Sir Joseph Whitworth, with photographs, were given by Mr. W. Price Abell, member; and the death of Mr. R. B. Buckley, Past-President, was announced. Information about the Society may be obtained from the Hon. Secretary, c/o Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	21/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 14 0	—
No. 1 Foundry	3 15 0	—
No. 3 Foundry	3 10 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 11 0	3 11 0
No. 1	3 11 6	3 11 6
Cleveland—		
No. 1	3 7 6	3 7 6
Silicious Iron	3 7 6	3 7 6
No. 3 G.M.B.	3 5 0	3 5 0
No. 4 Foundry	3 4 0	3 4 0
No. 4 Forge	3 3 6	3 3 6
Mottled	3 3 0	3 3 0
White	3 3 0	3 3 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	—	—
,, ,, Foundry	3 4 6 to 3 6 0	
(3) Northampton—		
Foundry No. 3	3 0 6 to 3 1 0	
Forge	2 14 0	—
(3) Derbyshire—		
No. 3 Foundry	3 5 0 to 3 6 0	
Forge	2 19 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 4 0 to 3 5 0	
No. 4 Forge	3 2 0	—
Basic	3 2 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 4 0 (a)	—
	4 7 0 (b)	—
	4 10 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	10 0 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	10 5 0	—
Best Bars	10 15 0	—
LANCS.—		
Crown Bars	10 0 0	—
Second Quality Bars	9 10 0	—
Hoops	12 10 0	—
S. YORKS.—		
Crown Bars	10 10 0	—
Best Bars	11 15 0	—
Hoops	12 10 0	—
MIDLANDS—		
Crown Bars	9 5 0 to 10 5 0	
Marked Bars (Staffs.)	13 0 0	—
Nut and Bolt Bars	9 0 0	—
Gas Tube Strip	11 10 0	—

STEEL. (d)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ½in. and up	8 2 6	7 12 6
Sections	7 12 6	7 2 6
Steel Sheets, ¼in.	8 17 6	8 15 0
Sheets (Gal. Cor. 24 B.G.)	13 12 6	£13 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 2 6	—
Angles	7 12 6	—
Boiler Plates	12 10 0	—
Joists	7 12 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	
Billets	7 10 0 to 10 0 0	
MANCHESTER—		
Bars (Round)	8 10 0	—
,, (Small Round)	7 10 0	—
Hoops (Baling)	10 5 0	10 0 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 7 6	—
,, (Lancs. Boiler)	10 5 0	—
SHEFFIELD—		
Siemens Acid Billets	10 0 0	—
Hard Basic	7 12 6 to 8 2 6	
Intermediate Basic	7 10 0	—
Soft Basic	6 10 0	—
Hoops	10 0 0 to 10 10 0	
Soft Wire Rods	9 0 0	—
MIDLANDS—		
Small Rolled Bars	7 7 6 to 8 0 0	
Billets and Sheet Bars	6 0 0 to 6 5 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	13 0 0 to 13 5 0	
Angles	7 12 6	—
Joists	7 12 6	—
Tees	8 12 6	—
Bridge and Tank Plates	8 7 6	—
Boiler Plates	11 0 0 to 11 10 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/- to 18/3
Block Tin (cash)	264 5 0
,, (three months)	261 15 0
Copper (cash)	59 11 3
,, (three months)	59 15 3
Spanish Lead (cash)	21 16 3
,, (three months)	22 2 6
Spelter (cash)	26 6 3
,, (three months)	26 0 0
MANCHESTER—	
Copper, Best Selected Ingots	66 10 0
,, Electrolytic	67 5 0
,, Strong Sheets	90 0 0
,, Tubes (Basis Price), lb.	0 1 0¾
Brass Tubes (Basis Price), lb.	0 0 11¾
,, Condenser, lb.	0 1 1¾
Lead, English	23 15 0
,, Foreign	22 12 6
Spelter	26 10 0
Aluminium (per ton)	£107

FERRO ALLOYS.

	Per Ton	Per Unit.
Tungsten Metal Powder	1/8 per lb.	
Ferro Tungsten	1/4 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
,, ,, 6 p.c. to 8 p.c. ,,	£22 17 6	7/3
,, ,, 8 p.c. to 10 p.c. ,,	£22 10 0	6/6
,, ,, Specially Refined		
,, ,, Max. 2 p.c. carbon	£36 0 0	11/6
,, ,, ,, 1 p.c. carbon	£41 10 0	15/-
,, ,, ,, 0·70 p.c. carbon	£53 0 0	17/6
,, ,, ,, carbon free	1/4 per lb.	
Metallic Chromium	3/- per lb.	
Ferro Manganese (per ton)	£13 0 0 for home £12 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/- per unit	
,, ,, 75 p.c.	£20 5 0 scale 6/- per unit	
,, Vanadium	14/3 per lb.	
,, Molybdenum	5/- per lb.	
,, Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£175	
Ferro-Cobalt	9/3 per lb.	

FUELS.

SCOTLAND.
(Prices not stable.)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	13/9
,, ,, Ell	14/6
,, ,, Splint	17/- to 18/6
,, ,, Trebles	14/3
,, ,, Doubles	14/-
,, ,, Singles	12/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/3
,, ,, Jewel	15/3
,, ,, Trebles	14/3
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 13/-
Screened Navigation	18/-
Trebles	14/9 to 16/-
Doubles	14/3
Singles	11/9
LOTHIANS—	
(f.o.b. Leith)—Best Steam	12/9
Secondary Steam	12/3
Trebles	14/6
Doubles	14/3
Singles	11/9

ENGLAND.

	Inland.	Export.
(8) N.W. COAST—		
Steams		24/- to 25/-
Household		40/- to 56/-
Coke		23/- to 24/-
NORTHUMBERLAND—		
Best Steams		13/6 to 14/-
Second Steams		12/9 to 13/-
Steam Smalls		9/- to 9/9
Unscreened		13/- to 13/6
Household		21/- to 27/-
DURHAM—		
Best Gas		15/9
Second		13/9 to 14/-
Household		21/- to 27/-
Foundry Coke		19/- to 26/-
SHEFFIELD—		
Best Hand-picked Branch	27/6 to 29/6	—
Derbyshire Best Bright House	20/6 to 21/6	—
Best House Coal	19/- to 20/6	—
Screened House Coal	16/- to 17/6	—
,, ,, Nuts	15/- to 16/-	—
Yorkshire Hards	14/6 to 15/6	—
Derbyshire Hards	14/- to 15/6	—
Rough Slacks	8/6 to 9/6	—
Nutty Slacks	6/- to 7/-	—
Smalls	3/- to 4/6	—
Blast-furnace Coke (Inland)	11/- to 12/- at ovens	—
Furnace and Foundry Coke (Export), f.o.b.		17/6 to 18/6

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	19/- to 19/6
Second Smokeless Large	18/6 to 19/-
Best Dry Large	18/3 to 18/9
Ordinary Dry Large	17/6 to 18/-
Best Black Vein Large	17/6 to 18/-
Western Valley Large	17/- to 17/6
Best Eastern Valley Large	17/- to 17/3
Ordinary Eastern Valley Large	16/6 to 17/-
Best Steam Smalls	12/6 to 13/-
Ordinary Smalls	11/- to 12/6
Washed Nuts	18/- to 22/-
No. 3 Rhondda Large	19/6 to 20/-
,, ,, Smalls	14/9 to 15/3
No. 2 ,, Large	16/- to 16/6
,, ,, Through	14/6 to 15/6
,, ,, Smalls	11/6 to 12/6
Foundry Coke (export)	30/- to 37/6
Furnace Coke (export)	27/6 to 30/-
Patent Fuel	22/6 to 24/-
Pitwood (ex ship)	27/9 to 28/3
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	32/- to 34/-
Seconds	26/6 to 29/-
Red Vein	20/6 to 25/-
Machine-made Cobbles	35/- to 40/-
Nuts	38/6 to 42/6
Beans	22/6 to 27/6
Peas	17/- to 18/6
Breaker Duff	8/6 to 9/-
Rubbly Culm	8/- to 8/6
Steam Coals:	
Large	17/6 to 18/6
Seconds	16/- to 17/-
Smalls	9/9 to 10/9
Cargo Through	15/- to 16/-

(1) Delivered. (2) Net Makers' works. (3) f.o.b. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. (d) Rebate 7/6 joists and 5/- all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(From our Correspondent in Paris.)

Iron and Steel Trades.

THE year closes with an impression that the European market is displaying a little more activity, which is partly due, no doubt, to the distribution of rail orders amounting to something like 187,000 tons. The trade returns for the first eleven months of the year also show a further increase in the exports of metallurgical products. The forthcoming distribution of orders for continuous brakes for goods trains, the contracts given out under the programme of naval construction, and the putting in hand of public works with the aid of German reparations, which provide for the supply of considerable quantities of material during the next few months, have also induced a feeling of confidence. The situation, however, is not so good as it would seem to be by this appearance of renewed confidence. There is little increase in the consumption of iron and steel, and while it is affirmed that stocks are being depleted and must be renewed, there is no doubt that stocks are heavy in merchants' hands, and that the mills and forges are running short time to avoid an accumulation. It is also affirmed that prices have got down to an absolute minimum. Nevertheless, offers were never so numerous, and sellers were never so accommodating as they are now. The elements of improvement in the situation are not visible, and the position of small manufacturers is particularly unsatisfactory, to the extent that suggestions are being made for a grouping of interests with a view of maintaining prices and distributing work amongst the members of each group. It is argued that if prices could be maintained buying would be more active. Therefore, it is hoped to organise groups of small manufacturers who would specialise in particular productions, while the sales would be effected by a central body. The system has proved particularly successful amongst the rail makers and tube firms, although it has not been found possible to carry out a similar organisation with respect to girders and other steel sections.

The Coal Agitation.

The suppression of licences for the importation of coal from January 1st has evidently only been brought about by the offer of concessions to coalowners who, it is affirmed, have succeeded in securing the drafting of a Bill for trebling the import duties on coal which will be presented to Parliament at the earliest possible moment in the hope that it will pass through without attracting attention. Coal consumers are up in arms against any increase in fiscal charges on fuel. They declare that an artificial inflation of coal prices with the aid of the licence system has had a depressing effect upon the metallurgical industries generally, and the syndicate of manufacturers in the Ardennes has issued a vigorous protest against the proposed Bill for increasing the import duties on coal and against the "exorbitant pretensions" of coalowners and the "selfishness of miners" who take no account of the interests of the great mass of workers and of consumers. The miners are agitating and are threatening to strike, and the Government is particularly anxious to avoid trouble of that kind on the eve of the elections.

Railway Deficits.

The Senatorial Commission of Public Works is making an inquiry into the causes of the railway deficits for 1927, amounting to about 1000 million francs, one half of which, however, is covered by the surplus for the preceding year, but, according to present estimates, the deficit for 1928 is likely to be not less than 1400 million francs. Normally, the passenger traffic provides from 22 to 27 per cent. of the receipts, but on account of the diminution in the number of passengers and the growing practice of travelling third-class, following upon the increase in rates, there was a decline in 1927 of 12 per cent. During the inquiry it was suggested that the remedy lay in reducing the tax of 33 per cent. on passenger tickets, revising the rates for journeys of more than 500 kiloms., increasing rates for express trains, and adjusting the rates for season tickets, which are certainly low. Some check must also be put upon the abuse of free passes. Goods traffic usually provides from 56 to 69 per cent. of the receipts, according to the railway, and during 1927 this declined by 13·4 per cent.

A Hydro-electric Accident.

A slight seismic shock in the Pyrenees has seriously damaged the underground canal of reinforced concrete, which brings the water from Lake Artouste to the Artouste, Miegebat and Hourat power stations, where 130,000 horse-power is supplied by thirteen turbines. The canal, having a length of 800 m., is twisted and threatens to fall in. Repairs will involve a considerable expense, and a heavy loss is sustained through the stoppage of the generating stations. The Pyrenees are frequently subjected to slight shocks, and in the case of the Artouste Canal the earthquake was not felt outside the mountain.

Domestic Heating.

The proposal to distribute steam for domestic heating has taken definite form by the constitution of the Société de Chauffage Urbain, which is negotiating for the purchase of the abandoned Metropolitan power generating station in the rue de Bercy. It will be connected up by a main with the Saint-Ouen generating station of the Campagnie Parisienne d'Electricite, where the superfluous steam will also be utilised, and will therefore traverse Paris from the Bastille to the Porte de Saint-Ouen. For the distribution the existing central heating installations will be used with some modification, and meters exist in Holland and Denmark which register accurately the number of calories consumed.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

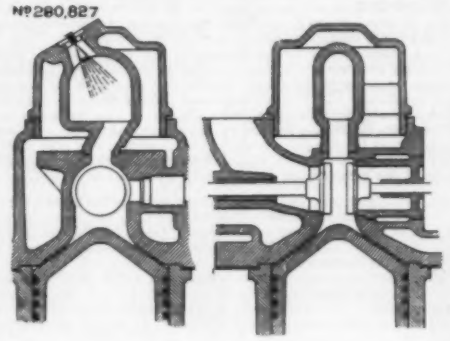
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

280,827. July 16th, 1927.—COMBUSTION CHAMBERS, S. J. Fielding, Atlas Works, Gloucester.

The essence of the claims in this specification is that the supplementary combustion chamber should be flattened longi-

Nº280,827



tudinally, as shown in the drawings, as compared with the usual more or less globular form. It is claimed that the flattened formation tends towards easy cold starting.—*November 24th*, 1927.

AERONAUTICS.

280,406. February 1st, 1927.—CONTROL GEAR, C. F. Uwins, 9, Apsley-road, Clifton, Bristol; and the Bristol Aeroplane Company, Limited, Filton House, Bristol.

This invention is concerned with tail planes of which the angle of incidence can be altered to suit the speed of flight. This angle

Nº280,406

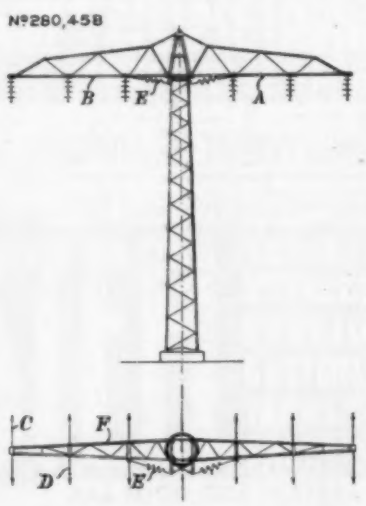
is controlled by the hand lever A and the bell crank B. The aerofoil C is operated by the control stick D through the linkage shown. When the hand lever A is pushed down the rod E is moved downward in the slotted link F and the leverage of the control stick is altered to suit the new angle of incidence.—*November 17th*, 1927.

TRANSMISSION OF POWER.

280,458. June 7th, 1927.—IMPROVEMENTS RELATING TO THE DAMPING OF OSCILLATIONS OF TRAVERSE ARMS OF HIGH-TENSION ELECTRIC CABLE MASTS, Frits Berg, of 13, Keppler-strasse, Mannheim, Germany.

This invention relates to means for damping the oscillations of a carrier arm of a mast carrying high-tension conductors, and it is intended to come into action when a cable breaks and

Nº280,458

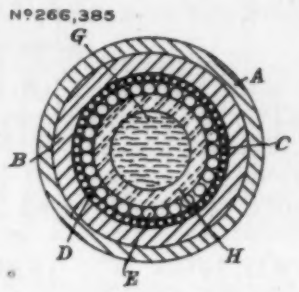


causes a sudden shock to be applied through the remaining cable. If an overload occurs on one of the arms A or B, owing to the breakage of one of the cables, and if this applies a force in the direction of the arrow C, a compensating force D is set up owing to the action of the spring E. The action of this spring causes a torsion to be applied to the mast upright, which forms the final abutment from which the torsional forces are resisted. The inertia of the arm F, however, first comes into action, and afterwards the spring E becomes effective, and finally the actual torsional force falls in a damped or restrained measure upon the mast upright.—*November 17th*, 1927.

266,385. February 21st, 1927.—IMPROVEMENTS IN ELECTRIC CABLES, Max Sieverts Fabriks Aktiebolag, of Esplanaden 7, Sundbyberg, Sweden.

This specification describes an oil-impregnated cable, and the object is to facilitate the expansion of the oil when the cable is heated by the current. The cable consists of a lead sheath A,

Nº266,385



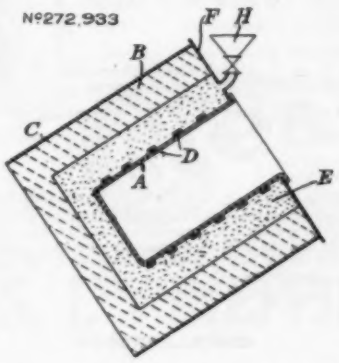
layers of insulation B and C, and conductors D. Strengthening wires are provided at E. At G there is a rubber core enclosed within a lead sheath H. The rubber core and the lead sheath H allow for the expansion of the oil, and when the current is cut off and the temperature of the cable decreases, the elasticity of these parts allows the oil to return to its original position.—*November 24th*, 1927.

FURNACES.

272,933. June 15th, 1927.—IMPROVEMENTS IN OR RELATING TO ELECTRICAL RESISTANCE FURNACES, Metallwerk Plansee G.m.b.H., of Reutte, Tyrol, Austria, and Paul Schwarzkopf, of Reichskanzlerplatz 10, Berlin Charlottenburg, Germany.

This specification describes an electric resistance furnace suitable for high temperatures. The furnace consists of a crucible or melting pot A, composed of quartz or zirconia, according to the temperature to be attained. B is a thermal insulation consisting

Nº272,933



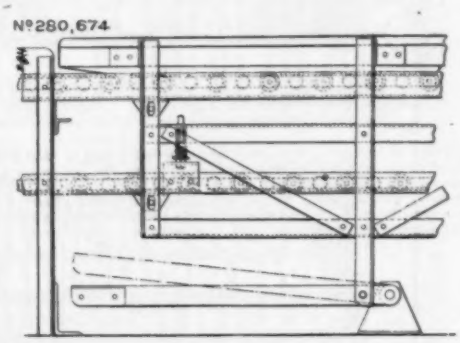
of chamotte and kieselguhr, which fits into a cast iron ring C. An electrical resistance coil composed of molybdenum, tungsten or alloys of these substances is provided at D, whilst the space E is filled with pulverised charcoal. The external closure is provided by a cover F, composed of cast iron, which supports the part A. In the event of the charcoal burning at the high temperatures, fresh charcoal can be fed in through the hopper H, which is provided with a cock.—*November 24th*, 1927.

CRANES AND CONVEYORS.

280,674. September 30th, 1926.—CONVEYORS, Spencer (Melksham), Ltd., and G. H. Bailey, Melksham, Wilts.

This invention is concerned with conveyors for moving boxes, crates and other packages, and really amounts to their conveyance on the top of rollers, which are driven as a string by

Nº280,674



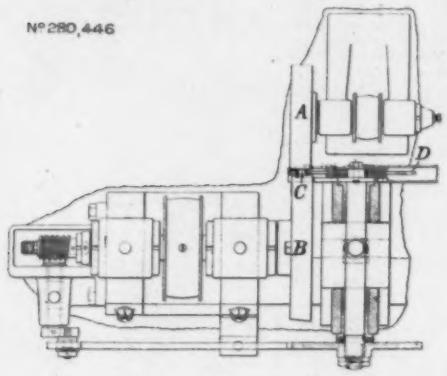
outside means connected with pivots on their ends. The result is that the packages travel at twice the speed of the driving mechanism. We introduce one of the drawings of the specification, but hardly any illustration is necessary.—*November 24th*, 1927.

MACHINE TOOLS AND SHOP APPLIANCES.

280,446. May 21st, 1927.—CENTRELESS GRINDING MACHINES, British Timken, Ltd., and F. Loader, Common-lane, Ward End, Birmingham.

This machine is intended for grinding such objects as the rollers of roller bearings. The rollers are ground between two

wheels A and B, which revolve in opposite directions and at different speeds. One of the rollers is shown at C and they are held in radial slots in a magazine wheel D which is rotated inter-

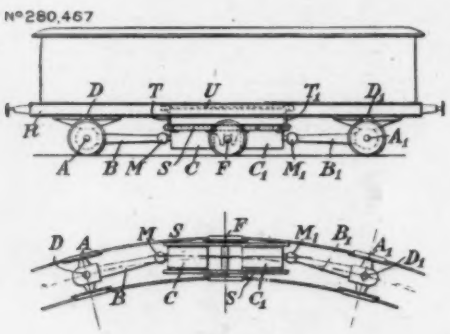


mittently. The rollers are fed into the top of the wheel and drop out below after having been ground.—*November 17th*, 1927.

TRAMWAYS AND RAILWAYS.

280,467. June 27th, 1927.—RADIAL AXLES FOR RAILWAY VEHICLES, Swiss Locomotive and Machine Works, Zurcherstrasse 41, Winterthur, Switzerland.

This vehicle has two carrying and driving axles A A_1 of the Bissel type. These axles are pivotally connected by means of the radius bars B B_1 at the points M M_1 to the motors C C_1.

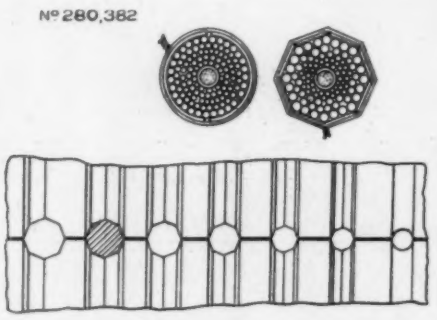


The vehicle body rests by the aid of pivot pins D D_1 on the driving and supporting axles A A_1. The motors C C_1 are mounted on the carrier system or intermediate frame S, which, by means of links T T_1 and shafts U, is suspended from the main frame R. The central axle F has its bearings provided in the frame S, and the latter swings relatively to the main frame R with the central axle F.—*November 17th*, 1927.

MISCELLANEOUS.

280,382. December 7th, 1926.—MAKING HOLLOW IRON BARS, T. S. Wheelwright, Buckhead Springs, Virginia.

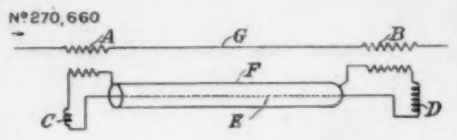
This invention is concerned with the manufacture of hollow stay bolt iron by building up a faggot of iron wire round a hollow core, filling the core with refractory material, welding the faggot together and then rolling it down to the desired dimensions. It has been found in practice that if the passes of the rolls are of



circular cross section this procedure causes the bar to turn and twist to an extent such that the hole through the centre of the bar becomes distorted, and sometimes at places becomes even closed. The inventor consequently uses polygonal passes for roughing down the faggot and only uses a circular section at the last pass. The refractory core is subsequently blown out by compressed air while it is being rotated in a lathe.—*November 17th*, 1927.

270,660. March 31st, 1927.—IMPROVEMENTS IN ELECTRIC CUT-OUT OR PROTECTIVE SYSTEMS WITH PILOT CONDUCTORS, Forges and Ateliers de Constructions Electriques de Jeumont, of 75, Boulevard Haussmann, Paris.

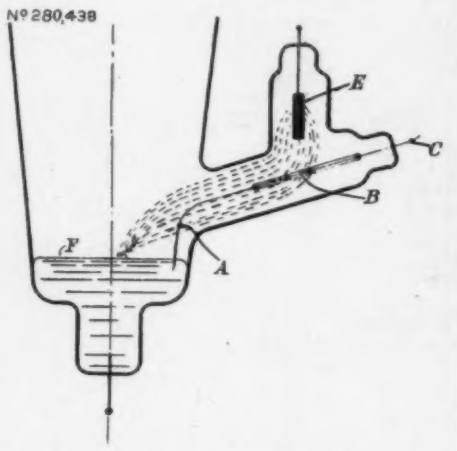
This specification describes a protective system for polyphase cables characterised by the fact that the protective pilot circuit corresponding to each phase consists of two conductors, one completely surrounded by the other, the outer return conductor being distinct from the metal sheathing. The object of the invention is to avoid the manifestation of high-potential differences produced between pilot wires by electro-magnetic coupling with the power cables. In the diagram A and B are the balancing transformers and C and D the windings of the corresponding



relays. E and F are the concentric conductors of the pilot cable corresponding to the conductor G of the power cable. In circuit with the conductors E and F the secondaries of the transformers A and B are connected as also are the relay windings C and D. The portion of the flux produced by the conductor G, which normally acts upon the conductor E, is considerably weakened by the presence of the return conductor or sheath F surrounding the conductor E. The arrangement differs from the use of a metal-sheathed cable containing the pilot wire or wires of a Merz-Price protective system in that a separate return conductor is provided for the pilot circuit of each phase, and also in that the return conductor of each pilot circuit surrounds the pilot wire of the same circuit and phase.—*November 17th*, 1927.

280,438. May 6th, 1927.—IMPROVEMENTS IN STARTING MEANS FOR MERCURY VAPOUR RECTIFIERS AND LIKE APPARATUS, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C. 2; and Ezechiel Weintraub, of 14, rue des Marronniers, Paris.

The starting electrode of the mercury vapour rectifier described in this specification is formed by a metallic rod A, which, when the rectifier is not at work, dips into the mercury of the cathode and it is supported by a bimetallic strip B with a connection C



attached to a side tube as shown. This side tube also contains one of the principal or sustaining electrodes E. As long as the rectifier is at work the strip B is heated directly by the arc which is indicated by the dotted lines; it is also heated indirectly by the heat radiated from the anode E. The bimetallic strip is designed so that even when the minimum amount of current is flowing from the anode E the heat will cause it to be sufficiently deformed to keep the electrode A outside the mercury.—*November 17th*, 1927.

269,558. April 12th, 1927.—METHOD OF MANUFACTURING HIGH OHMIC RESISTANCES, Bernhard Loewe and Loewe-Radio G.m.b.H., both of Wiesenweg 10, Berlin-Steglitz, Germany.

The preparation of high ohmic resistances of 100,000 ohms and above presents considerable difficulties. The usual practice of using rods of semi-conducting material, the inventors state, has not proved satisfactory, as the silicon compounds which are generally used display the so-called effect of "remanence." Wire-wound resistances are also unsuitable for many purposes on account of the excessive length of wire required and the inductive and capacity effects. It has been found that deposits of metal can be formed in layers in a comparatively simple manner upon an insulating support, and that their electrical resistances varies from 100,000 ohms up to several megohms. The process consists in dissociating, by means of heat or under the influence of electrical discharges, metallic hydrides, either alone or diluted with hydrogen, and forming a deposit of a metal or a metalloid upon a suitable insulating supporting body. The term metalloid is not intended in this specification to include carbon. By dilution with hydrogen or with an inert gas such as nitrogen the thickness of the deposit can be regulated, and thus the magnitude of the resistance can be determined in advance. In many cases it has been proved advantageous to assist the deposition of the metal from the hydride by the addition of suitable amounts of oxygen. According to one method of carrying out the invention, a dry stream of gas containing 20 parts of arsenic hydride to 100 parts of hydrogen is passed through a tube of Jena glass of small internal diameter and provided with two lead-in electrodes, the tube being heated to 500–600 deg. Cent. In this manner a deposit of arsenic is produced, the thickness of which is increased until measurements made between the electrodes show that the desired resistance has been attained. Instead of arsenic hydride a hydride of tin may be used.—*November 17th*, 1927.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

TO-DAY.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecturette, "The Burmese Lacquer Industry," by Mr. A. P. Morris. 7.30 p.m.

SATURDAY, DECEMBER 31ST.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle street, London, W. 1. Children's Christmas Lecture, "Engines (II). Learning About Steam," by Professor E. N. da C. Andrade. 3 p.m.

MONDAY, JANUARY 2ND.

INSTITUTION OF AUTOMOBILE ENGINEERS: WESTERN CENTRE.—Merchant Venturers' Technical College, Bristol. Paper, "The Electrical Characteristics of Spark Gap and Sparking Plugs," by Mr. E. A. Watson. 6.45 p.m.

TUESDAY, JANUARY 3RD.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "Some Notes on Reorganising a Works to Increase Production," by Mr. C. R. F. Engelbach. 7.45 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Broadgate Café, Coventry. Coventry Graduates' meeting. Paper, "Case-Hardening of Carbon Steels for Automobile Purposes," by Mr. H. Swain. 7.15 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Children's Christmas Lecture, "Engines—III., Engines which Work To and Fro," by Professor E. N. da C. Andrade. 3 p.m.

WEDNESDAY, JANUARY 4TH.

INSTITUTION OF CIVIL ENGINEERS: MANCHESTER AND DISTRICT ASSOCIATION.—Literary and Philosophical Society's Rooms, 36, George-street, Manchester. Paper, "Fatigue and Wear Testing of Materials," by Mr. J. S. Glen Primrose 6.45 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. Papers: "Rotating Loop Radio Transmitters and their Application to Direction-finding and Navigation," by Messrs. T. H. Gill and N. F. S. Hecht; "Some Experiments on the Application of the Rotating Beacon Transmitter to Marine Navigation," by Dr. R. L. Smith-Rose and Mr. S. R. Chapman; "A Theoretical Discussion of Various Possible Aerial Arrangements for Rotating Beacon Transmitters," by Dr. R. L. Smith-Rose. 6 p.m.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—Caxton Hall, Westminster, London, S.W. 1. Lecture, "Oil Fuel Burning for Central Heating and Domestic Boilers," by Mr. G. Urquhart Morgan. 7 p.m.

THURSDAY, JANUARY 5TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Papers: "Storage Batteries in Relation to Modern Supply of Electric Lighting and Power," by Mr. E. C. McKinnon. 6 p.m.

FRIDAY, JANUARY 6TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, London, S.W. 1. Thomas Lowe Gray Lecture, "The Marine Oil Engine," by Professor C. J. Hawkes. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Exhibition of Instruments and Scientific Appliances. 6 p.m.

TUESDAY, JANUARY 10TH.

INSTITUTE OF MARINE ENGINEERS.—85–88, The Minories, Tower Hill, London, E. 1. Paper, "The Effect of Type and Disposition of Machinery on the Strength of Ships," by Mr. T. R. Thomas. 6.30 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. Annual general meeting. 7.30 p.m.

TUESDAY TO THURSDAY, JANUARY 10TH TO 12TH.

PHYSICAL AND OPTICAL SOCIETIES.—Imperial College of Science and Technology, South Kensington, London, S.W. 7. Eighteenth Exhibition of Electrical, Optical and other Physical Apparatus.

WEDNESDAY, JANUARY 11TH.

OVERHEAD LINES ASSOCIATION.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. "French Regulations," by Major Theodore Rich. 5.30 p.m.

END OF VOL. CXLIV.

FOR SALE
Continued from page 2

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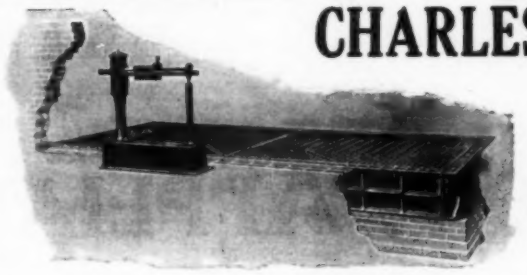

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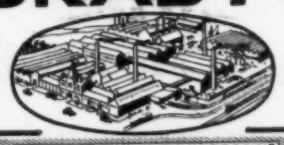

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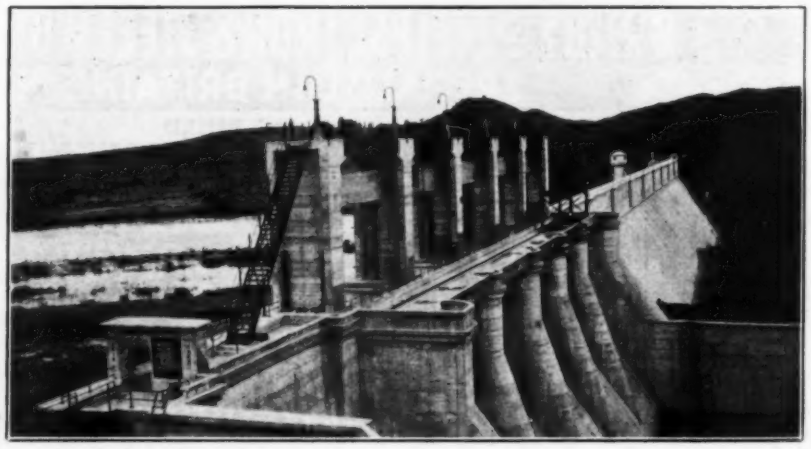

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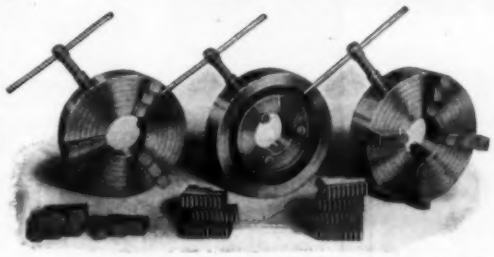

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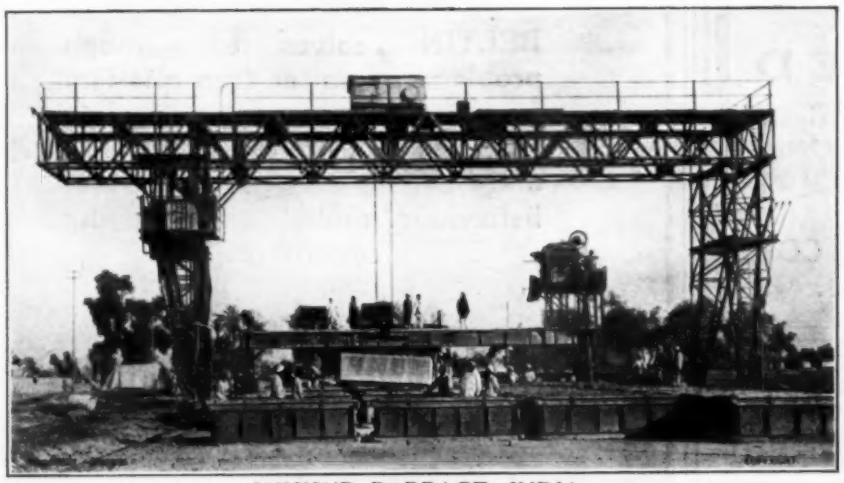

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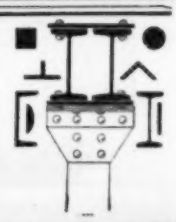

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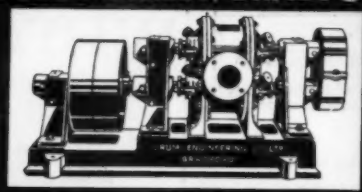
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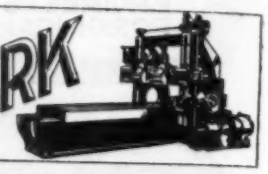

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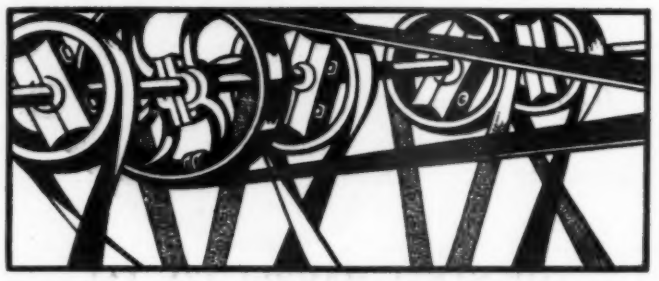
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BELTING solves many tough problems of power transmission. It is your security against stoppage and loss of power and carries a guarantee of behaviour under any running conditions.
Write the Sole Manufacturers—
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STAINLESS STEEL & IRON
Made by the Inventor at
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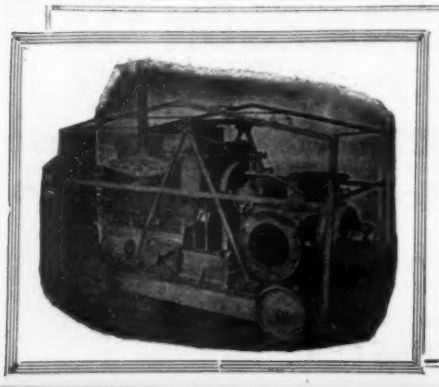
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These pumps do not consist merely of an oil engine coupled to a centrifugal pump. Each set is a unit specially designed for salvage work, and for no other purpose.
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TO THE LARGEST DIMENSIONS AND CAPABILITIES

PATENT CUTTER HOPPER DREDGERS, FLOATING CRANES, DIPPER DREDGERS,
ROCK BREAKING PLANT (Underwater) GOLD & TIN RECOVERY DREDGERS, AND DRAG LINE DREDGERS,
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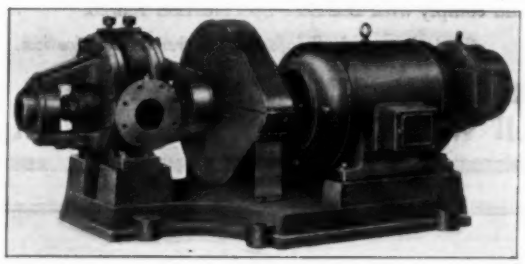
THE "STONE-PARAMOR" ROTARY PUMP is constructed on Scientific Principles and specially designed for handling fuel and lubricating oils, and industrial viscous fluids.



Rolling action between inner and outer rotor reduces friction to a minimum.

Made in all sizes up to 550 tons per hour capacity.

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Made in our own factory, from centres of reliable English Strap Butts—no "shoulders" used. Also Willcox's "Balatite" (regd.) Balata Belting, etc.

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COMPRESSED ASBESTOS JOINTING
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For high pressure steam, oil, petrol, acid, etc., joints.
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For the production of castings in large quantities **STERLING ROLLED STEEL MOULDING BOXES** are ideal. They possess all the essential qualities necessary for rapid handling—lightness, rigidity, durability, permanent accuracy, freedom from distortion and freedom from breakage.

All Sterling Boxes are made to specification and to suit the individual needs of each Foundry. They are designed for use with either fixed or loose pins, and we will drill them to suit your existing pattern plates.

We have a comprehensive range of standard styles covering every foundry service. Send your next moulding box enquiry to the leading moulding box manufacturers.

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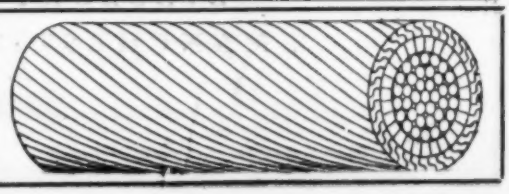
LOCKED WIRE ROPE

SMOOTH SURFACE, VERY FLEXIBLE



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DOES NOT TWIST IN WORKING.

Use all the power you pay for

NO power waste by slip or friction can occur where chain drives are installed—just smooth, regular turning with a minimum of noise and vibration.

Chain Drives incorporate all the advantages and none of the disadvantages of all other forms of transmission gear. They are positive, flexible, compact, and highly efficient.

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STOCK DRIVES FROM 1 TO 100 H.P. LARGE RANGE OF SPEEDS AND RATIOS DELIVERY WITHIN 24 HOURS

HANS RENOLD LIMITED
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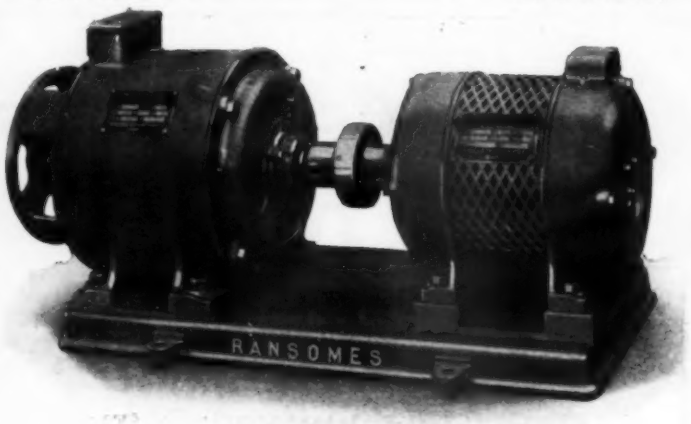
Ransomes
Motor Generator Sets
for Battery Charging.

A.C. to D.C. **D.C. to D.C.**



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IS 60% WORTH WHILE?

IF SO
WHY **DON'T** YOU USE
A PIPE FRAME
(Sturrock's Patent)
FOR **ALL** TEMPLATED PIPES?

This tool has been well tried out and supersedes wooden templates for templated pipes in leading shipyards, engineering works, coppersmiths, and chemical works on Clyde and Tyne. It is

LIGHT, RIGID & ACCURATE,

saves 60% of labour costs on templated pipes, gives more accurate work. Pipes can be finished from it with holes bored in flanges ready for erection—Pipe Frame is re-usable.

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L. FERGUSON, LTD.,
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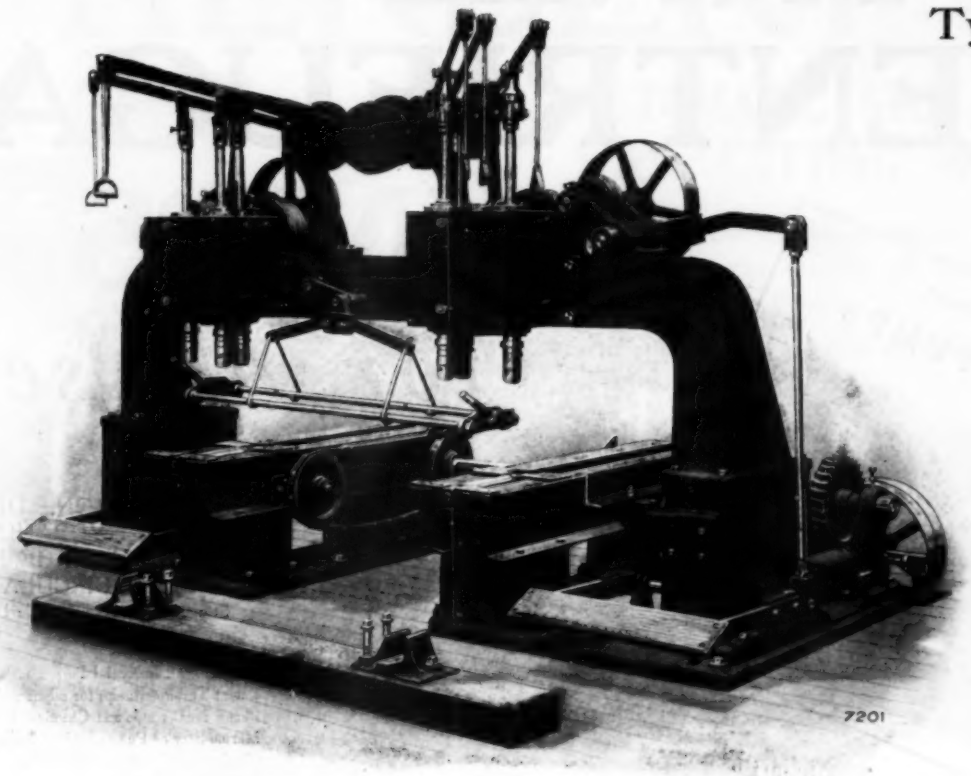
Sleeper Chairing or Screw Driving Machine

Type R B.



A rapid and economical machine for driving the screw spikes for fixing rail chairs to sleepers.

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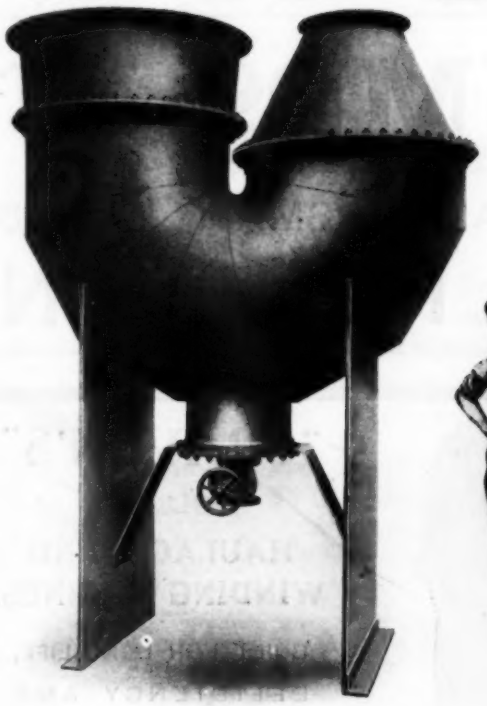

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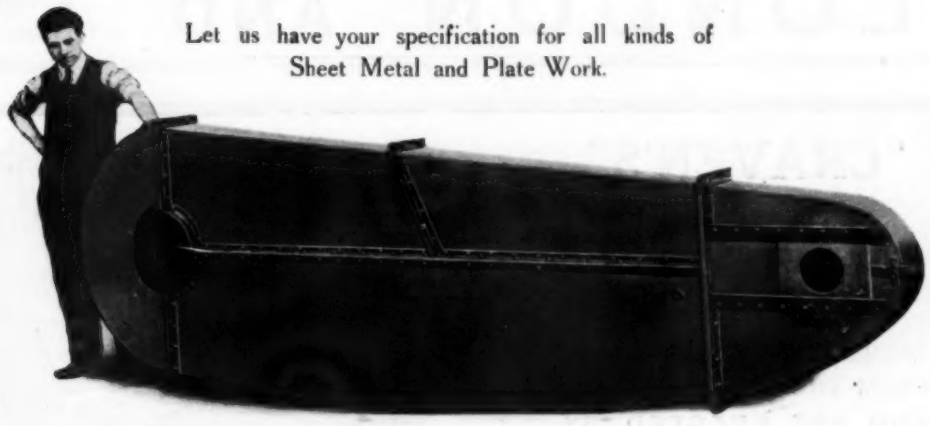

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"INVINCIBLE"
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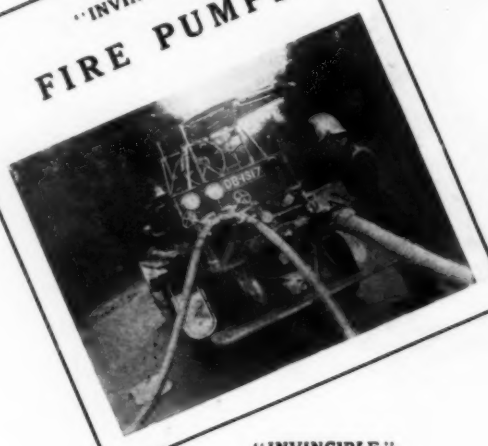

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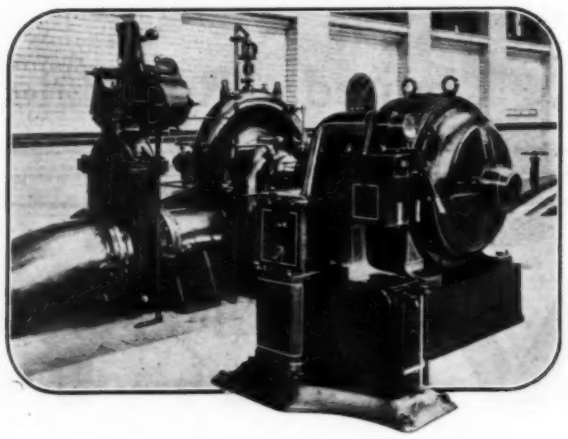

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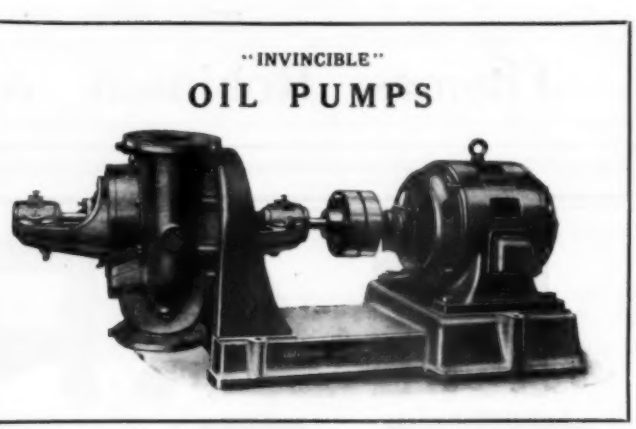
OIL PUMPS



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HIGH-CLASS
SHEET METAL WORKING MACHINERY.

THESE MACHINES ARE MADE FROM THE BEST MATERIALS AND ARE ERECTED BY SKILLED MECHANICS.

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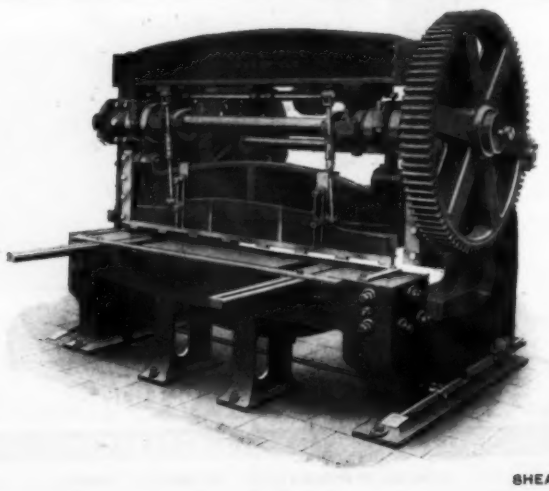
ILLUSTRATION OF OVERHEAD TYPE GUILLOTINE.



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COLLIERY
HAULAGE AND WINDING ENGINES.

BUILT FOR LONG LIFE, EFFICIENCY AND PERFECT PRECISION.

WAKEFIELD, ENGLAND.
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SHEARING MACHINE FOR CUTTING SHEETS 7' 0" x ⅜" THICK.

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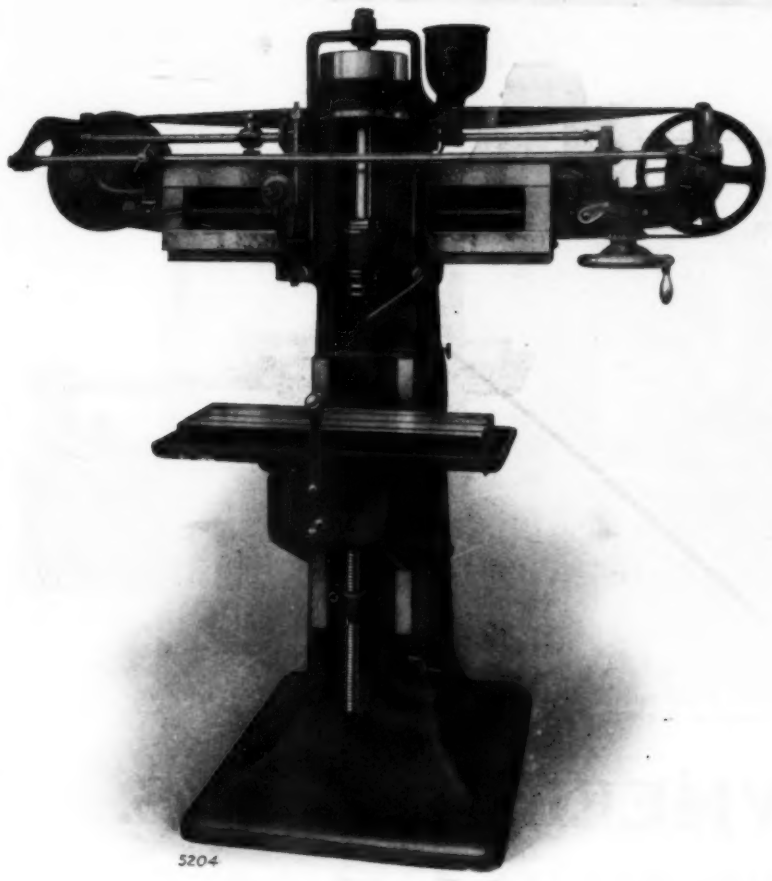

AUTOMATIC SLOT & KEY-WAY CUTTING MACHINE.

SLOTS and Keyways can be cut rapidly and more economically on this machine than by any other method.

The machine is entirely automatic and easy to operate.

Adjustable stops for tripping and reversing the automatic traverse of the spindle head are provided.

The vertical feed of the spindle is automatically disengaged when the desired depth of cut has been reached.

Maximum width of keyway cut	..	1¼"
Maximum length of keyway cut	..	20"

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DELIVERY FROM STOCK.

ALFRED HERBERT LTD. COVENTRY

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Adapt, Adopt, Improve

The practical interpretation of a famous slogan.

THE very existence of British Ropes Limited is a move by some of the most famous rope manufacturing businesses towards adapting themselves to the better service of the rope using industries.

The accumulated experiences and resources of all the factories comprising British Ropes Limited has enabled them to adopt every possible modern facility known to rope-making practice in all their works. The most approved principles of organisation for highest grade production have also been adopted with the greatest success.

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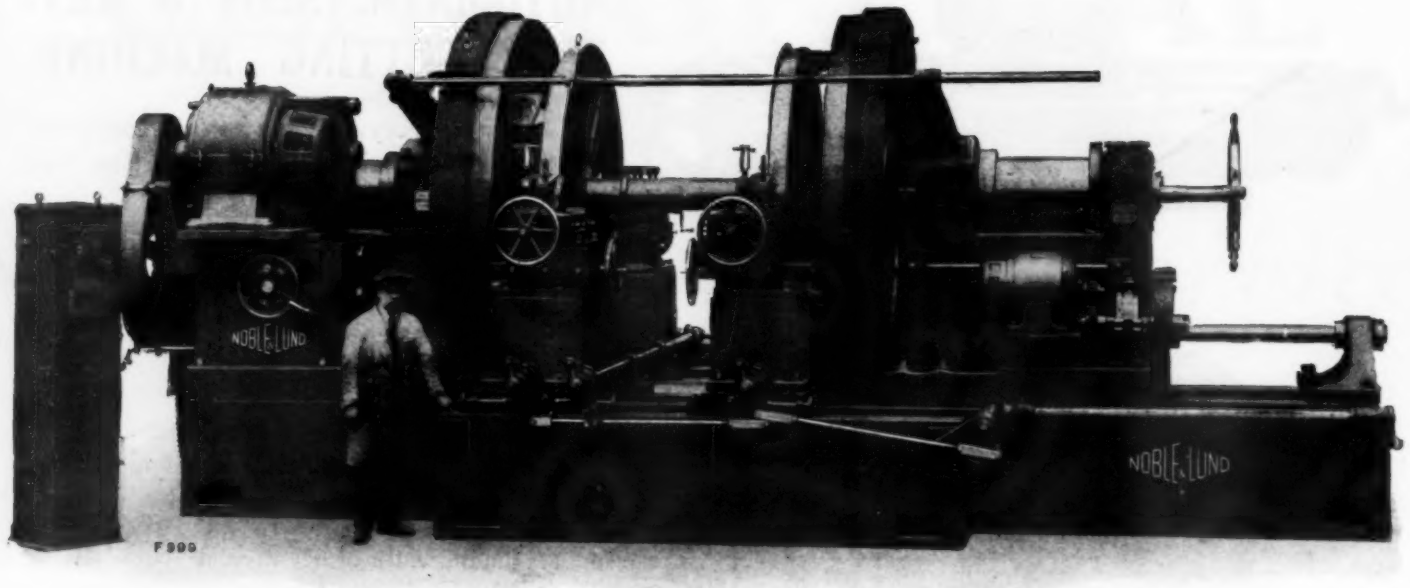

90in. Heavy Duty Railway Wheel Lathe, Single Purpose Type, turning 6ft. 10in. locomotive wheels. Back tool rests are fitted for turning down the sides of the tyres without interfering with the tools at the front of the lathe.

RAILWAY WHEEL LATHES.

MORE than fifty Noble and Lund Heavy Duty Railway Wheel Lathes are used by important Railway Companies throughout the world.

The machines are of very massive construction and can be supplied with a crane or rolling-in apparatus which facilitates mounting and removal of the wheels. A very high output is obtained.

Controls are placed in the most convenient position and tool changing is eliminated except for re-grinding.

We shall be very pleased to demonstrate these machines by appointment.

They are made in 5 sizes for wheels up to 37in., 48in., 66in., 78in. and 90in. diameter.

CATALOGUE ON REQUEST.

A few users of Noble & Lund Heavy Duty Wheel Lathes:—

London, Midland and Scottish Railway	4 Lathes
London & North-Eastern Railway	7 ,,
Great North of Scotland Railway	1 Lathe
Great Western Railway	1 ,,
North British Railway	1 ,,
Great Indian Peninsula Railway, India Store Depot	4 Lathes
Egyptian State Railway	1 Lathe
Buenos Ayres Great Southern Railway	1 ,,
Buenos Ayres Pacific Railway	2 Lathes
North-Western Railway, India Store Depot	4 ,,
Jodhpur Bikanir Railway, India Store Depot	2 ,,
Bengal Nagpur Railway	3 ,,
Rhodesia Railways	1 Lathe
Carro Ferril Lorenco Marques, Mozambique	1 Lathe
New South Wales Government	3 Lathes
Eastern Bengal Railway, India Store Depot	3 ,,
Edinburgh Corporation Tramways	1 Lathe
Aberdeen Corporation Tramways	1 ,,
Calcutta Tramways	1 ,,
Bombay Tramways	1 ,,

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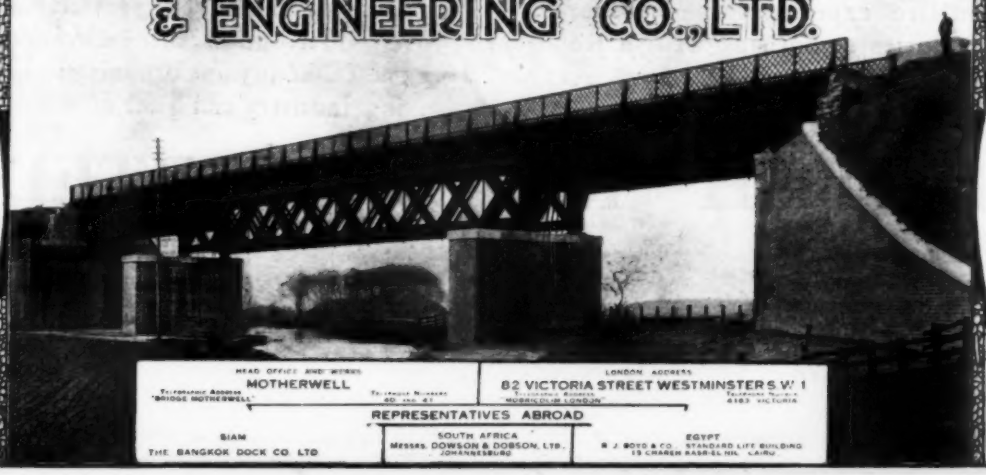
STRUCTURAL STEEL AND IRON-WORK OF EVERY DESCRIPTION. BRIDGES, ROOFS, STEEL FRAMED BUILDINGS, CRANE GIRDERS CRANE GANTRIES, CHIMNEYS, PIT HEAD FRAMES, TOWERS, RIVETTED PIPES.



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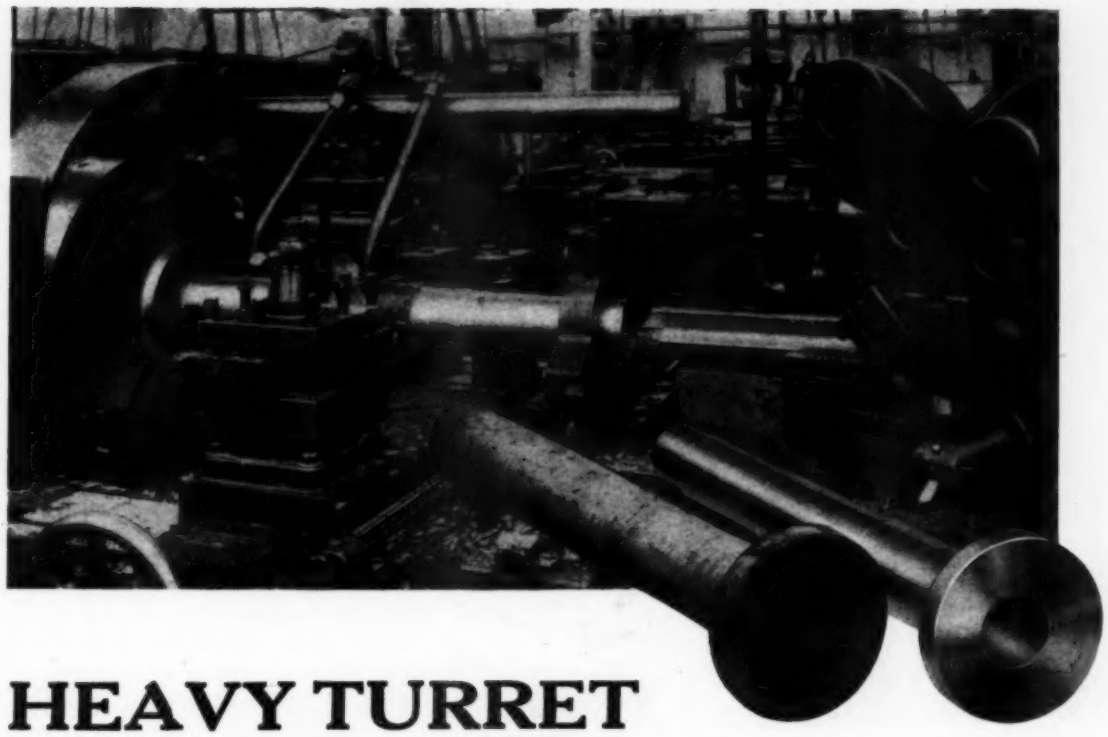

HEAVY TURRET LATHE WORK.

THE spindle for the Herbert No. 9 Combination Turret Lathe is made from a 50-ton tensile steel forging which weighs 3¼ cwts. The finished spindle weighs ¾ cwt. It is bored through and finish turned, ready for grinding, in two operations on a Herbert No. 20 Combination Turret Lathe. Hole is 3⅝" diameter by 32" long. The total machining time is 2 hours 8 minutes.

Look at the illustration and note the gripping power of the Coventry Chuck—the forging is held by only ¼" on the flange; the overhead support which ensures absolute rigidity under the heaviest cut; the tools arranged for turning and boring simultaneously.

Let us give you guaranteed production times on some of your work.

HERBERT COMBINATION TURRET LATHES ARE MADE IN THREE SIZES:—

No. 3 .. 8" centres
No. 9 .. 10" centres
No. 20 .. 13" centres

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WE QUOTE FOR AND SUPPLY

BUILDINGS AND PLANT COMPLETE.

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STRUCTURAL WORK FROM SECTIONS OR PLATES; PATTERNS, AND PERFECT CASTINGS UP TO 7½ TONS.

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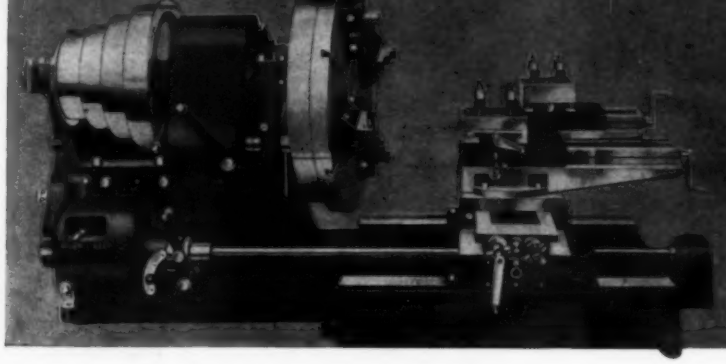
MANCHESTER · LEEDS · GLASGOW · BIRMINGHAM

LANG for LATHES



AND LATHES for EVERY PURPOSE!

The full range of Lang Lathes includes Centre Lathes and Chucking Lathes in many different designs & sizes. They are all good lathes: good, because they are dependable for quick output rates.

Next time you want a lathe, let us give you some output figures. Meanwhile our catalogue should be in your file.

JOHN LANG & SONS, LD.
JOHNSTONE.

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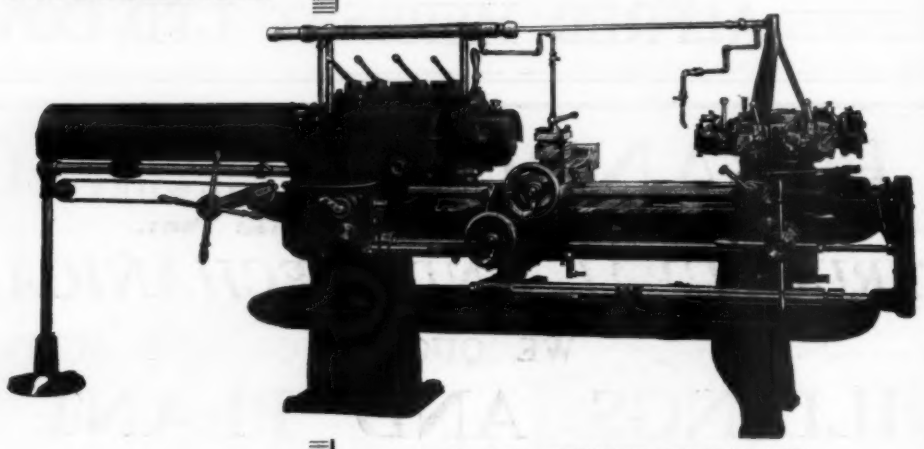
CAPSTAN LATHES
TURRET LATHES
BROACHING MACHINES

EARLY DELIVERY can be given of all types.

Full particulars on request.

HIGHLY PRODUCTIVE AND ECONOMICAL ON BOTH CHUCK AND BAR WORK.

Production times on your work will be submitted on receipt of samples or drawings.



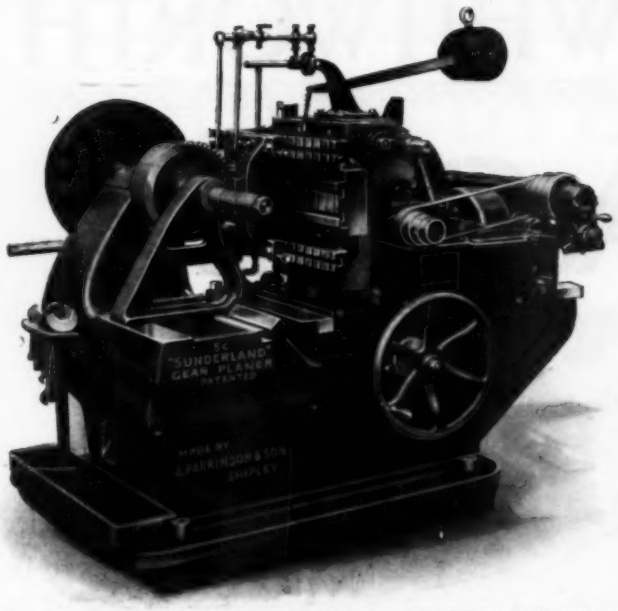
2in. × 30in. HEXAGON TURRET LATHE.

H. W. WARD & Co., Ltd.,
Selly Oak - - BIRMINGHAM.

BRITISH BUILT MACHINES

TOOL MAKERS LIMITED

LONDON, S.W.1.



CUT THE COST
AND IMPROVE THE QUALITY.

OUR 5c "SUNDERLAND"
GEAR PLANER FOR WHEELS UP TO 24" DIA., 5" FACE, 4 D.P., USING TWO CUTTERS.

WILL GENERATE 4 CAST IRON GEARS 74 T., 4 D.P., 2" FACE IN 80 MINS. OR

20 MINS. EACH.

J. PARKINSON & SON,
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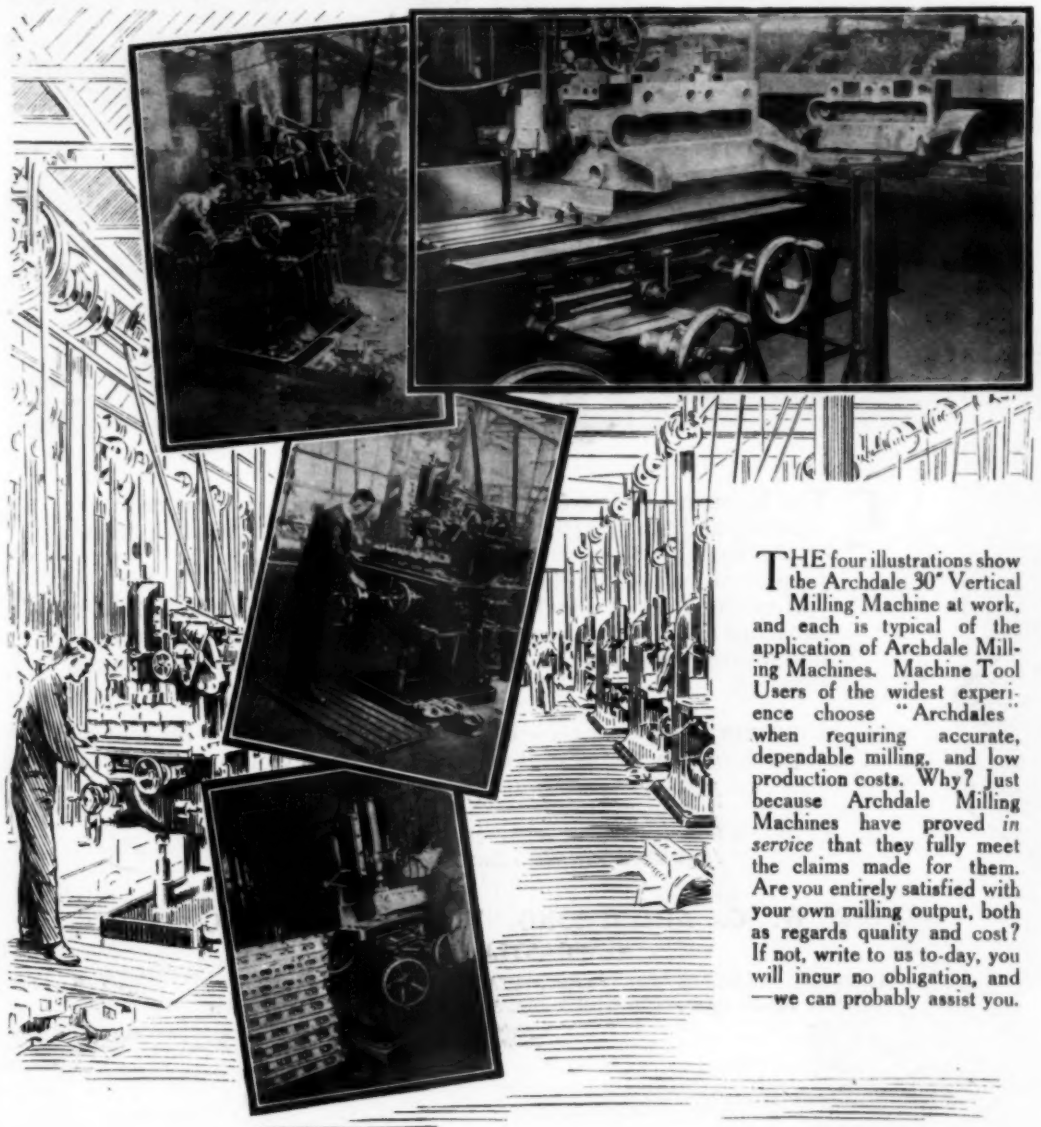
NEWCASTLE · PARIS · BRUSSELS · CALCUTTA

Archdale Milling

means

High Quality Output—Low Operating Costs.



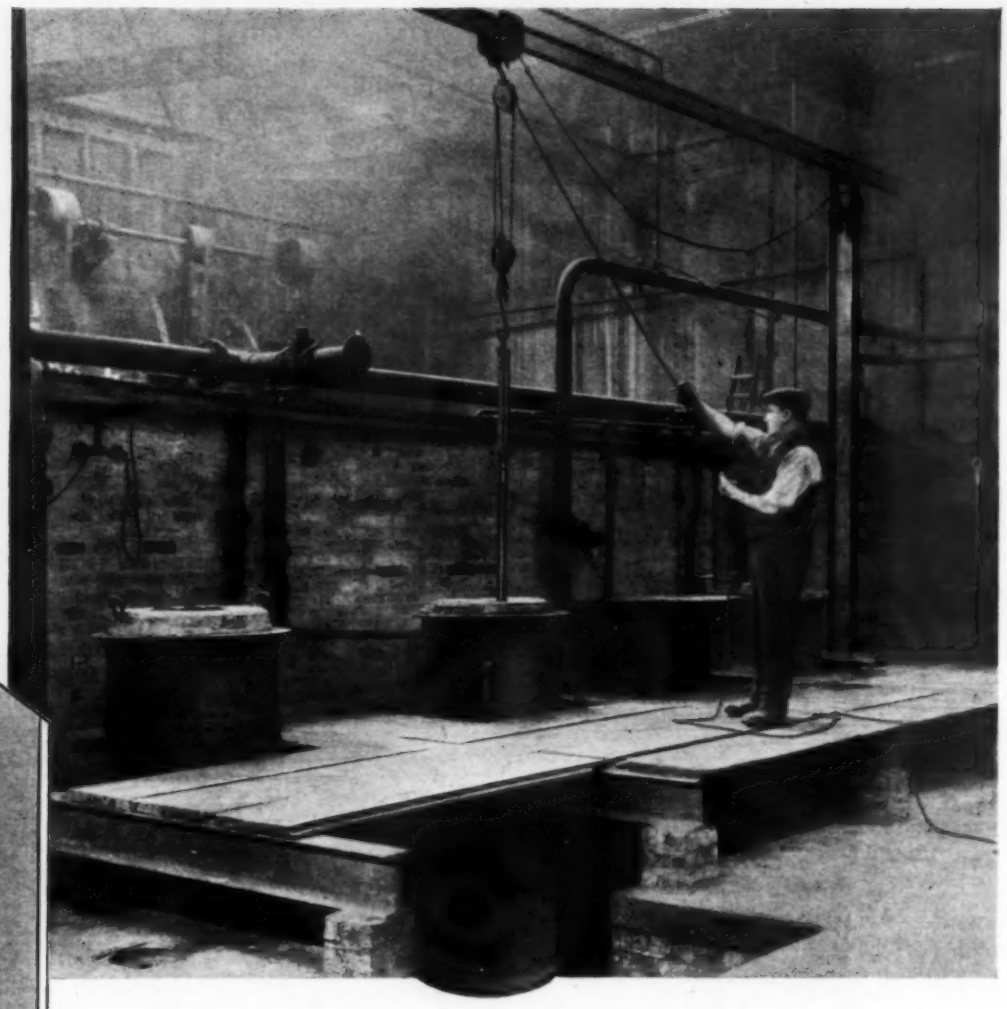
THE four illustrations show the Archdale 30" Vertical Milling Machine at work, and each is typical of the application of Archdale Milling Machines. Machine Tool Users of the widest experience choose "Archdales" when requiring accurate, dependable milling, and low production costs. Why? Just because Archdale Milling Machines have proved *in service* that they fully meet the claims made for them. Are you entirely satisfied with your own milling output, both as regards quality and cost? If not, write to us to-day, you will incur no obligation, and—we can probably assist you.

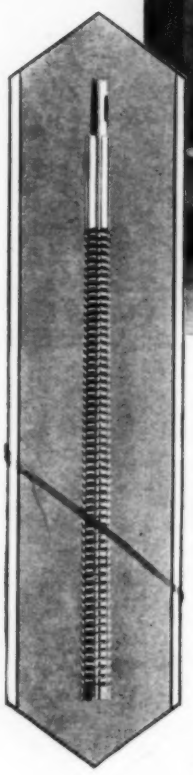
James Archdale & Company, Limited,
LEDSAM STREET. *Wires: "ARCHDALE, B'HAM."* *'Phone: Edgbaston 2276 & 2277.* BIRMINGHAM.

BRITISH BUILT MACHINES

ARMSTRONG·WHITWORTH

BROACHES





¶ The features which are of the most importance in these tools are accuracy and a satisfactory degree of hardness over the whole length of the broach. One or two soft teeth will ruin a broach for the purpose of producing a first-class job. We have specially designed vertical furnaces at our Openshaw Works for the heat treatment of broaches up to 6ft. in length, and our knowledge and experience of fine measurements enable us to ensure the high degree of accuracy required.

Brochure 9 gives details of our Broaches and will be sent on request. Other Brochures dealing with small tools are as follows:

Reamers	*Brochure* 10
Twist Drills	*Brochure* 15
Screwing Apparatus	*Brochure* 36
High Speed Steel Hack Saw Blades	*Brochure* 343

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Telephone: Gerrard 9474. *Code:* Bentley's. *Telegrams:* Zigzag, Piccy, London.

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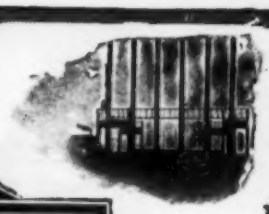

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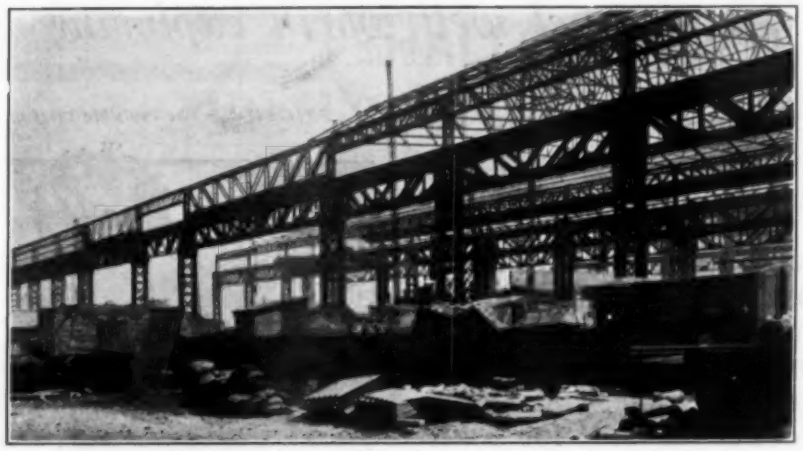

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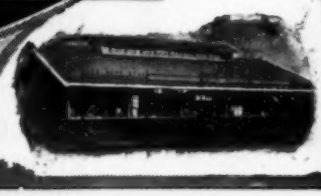

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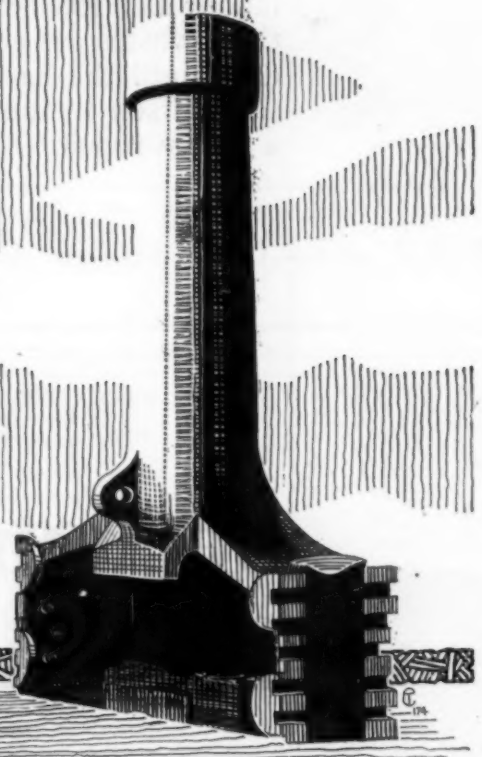

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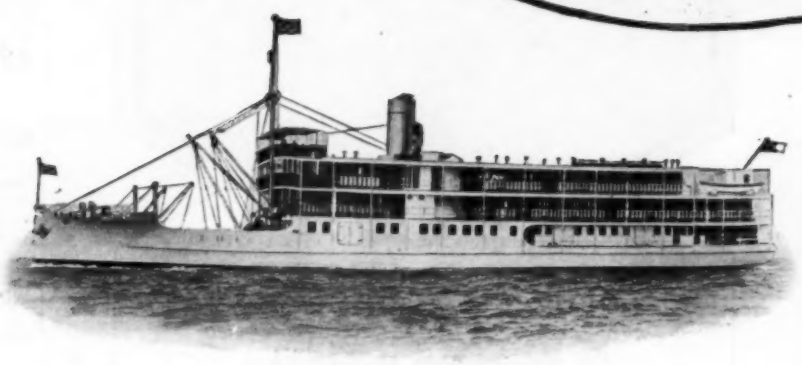

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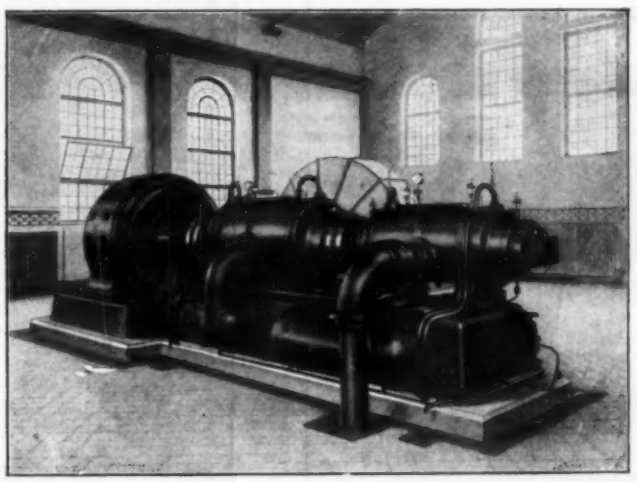

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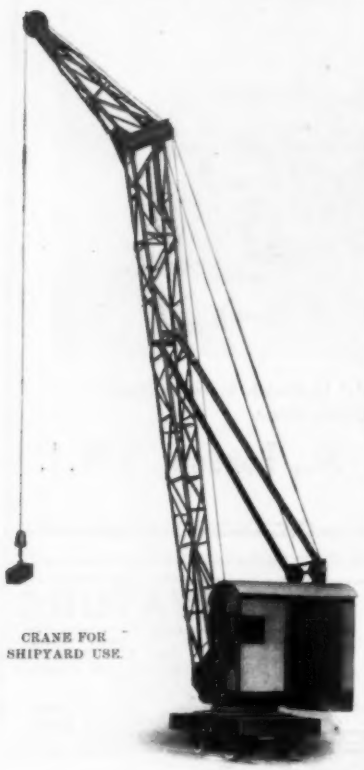

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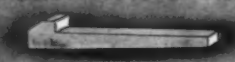

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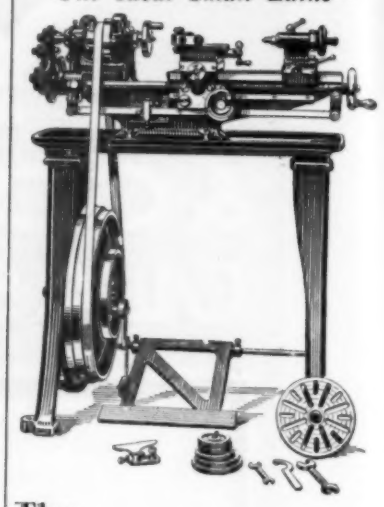

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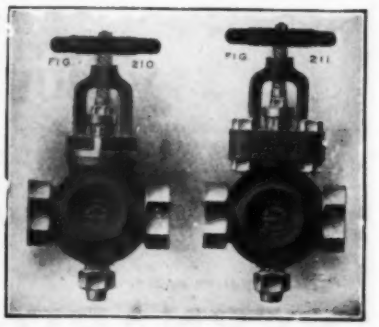

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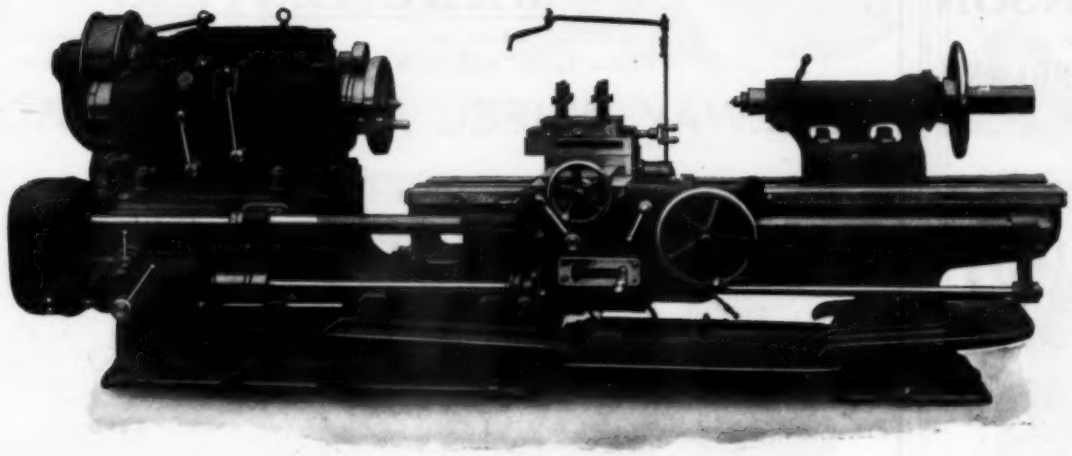

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THE LATHE IS FITTED AS STANDARD WITH RANGE				AND CAN BE INCREASED BY THE PARTIAL TURN OF A NUT TO			
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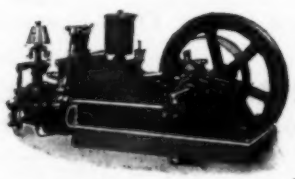

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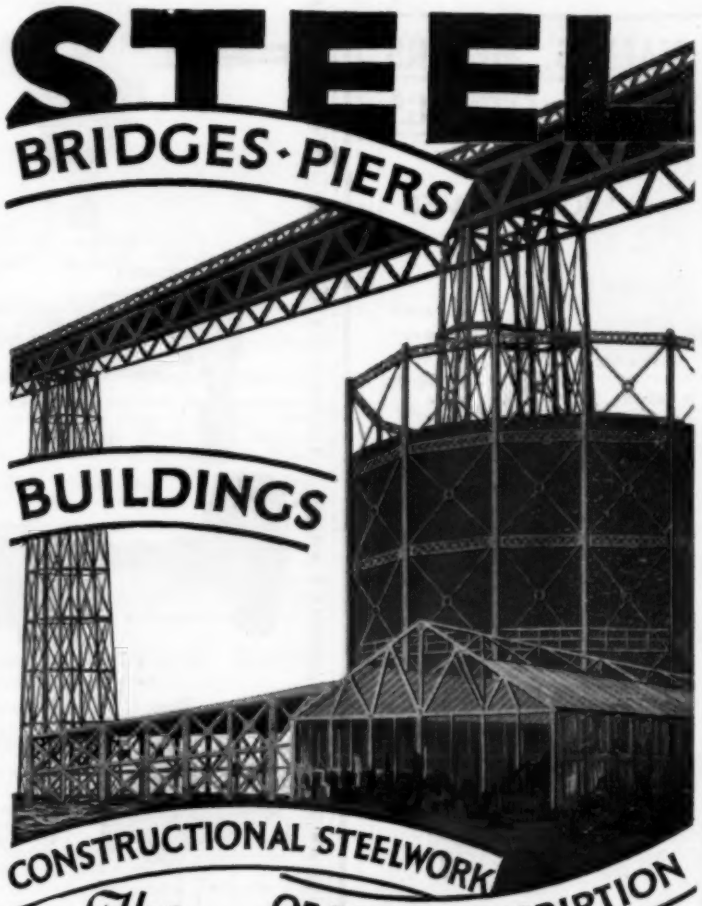

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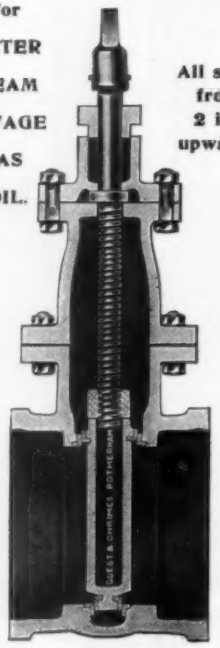

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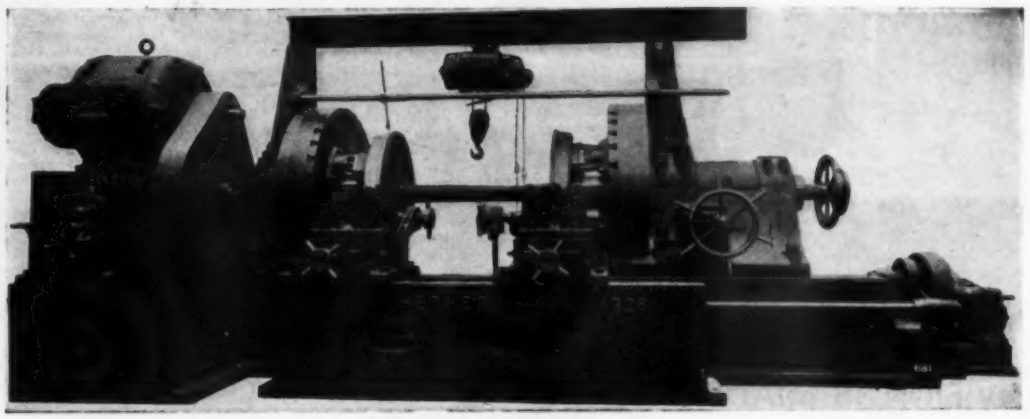

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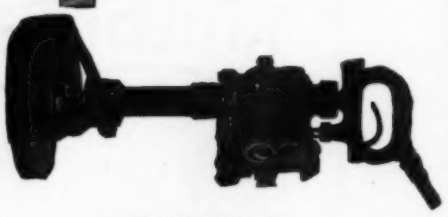

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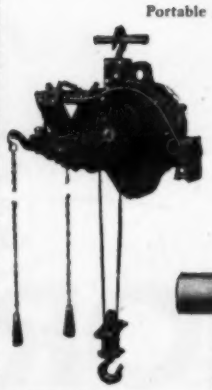

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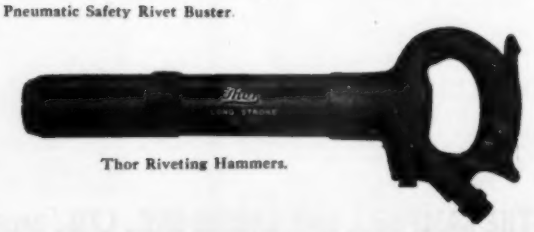

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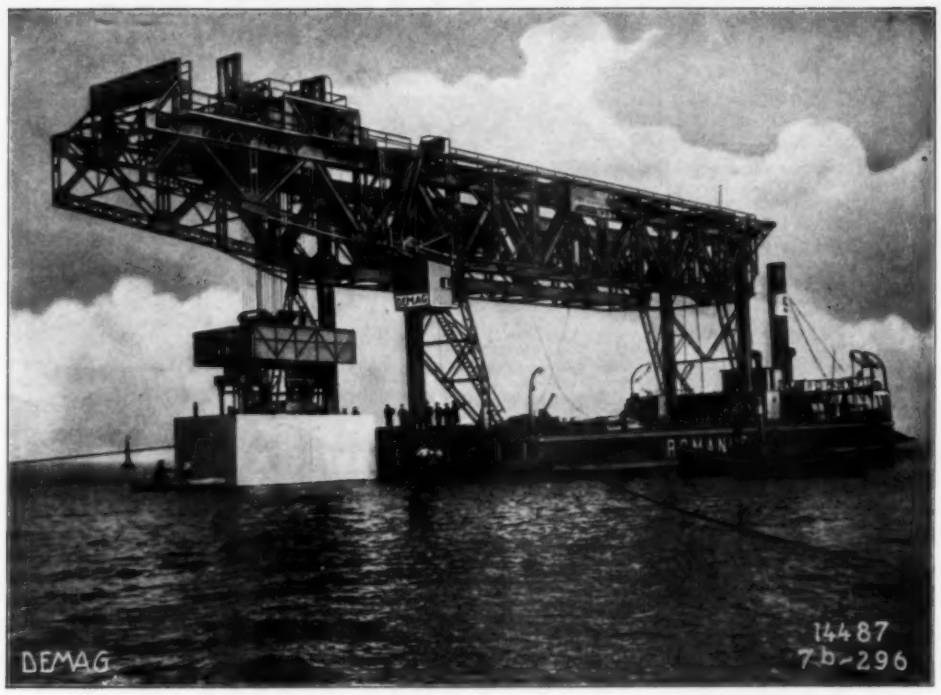

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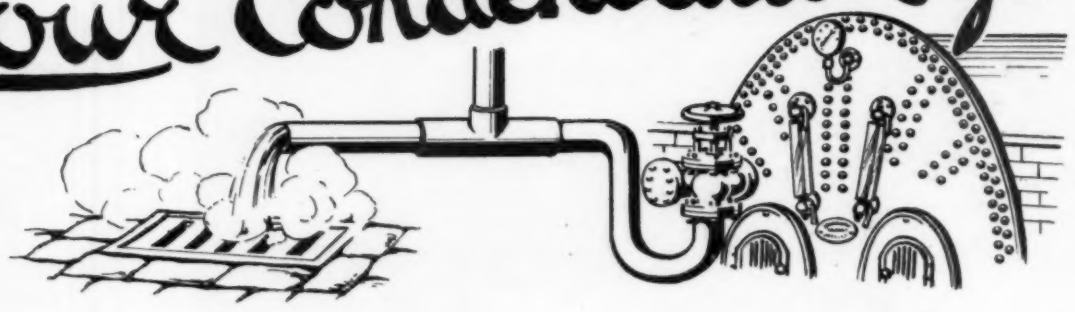

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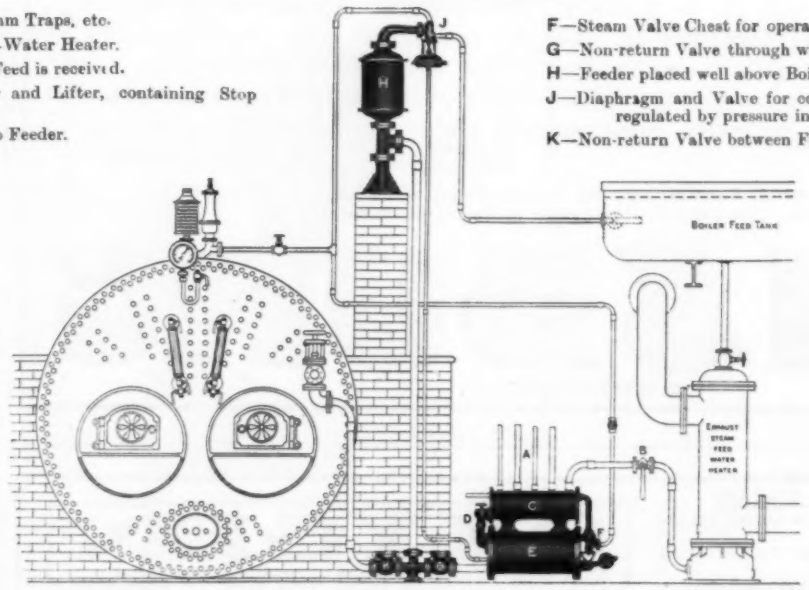
WILL DELIVER YOUR CONDENSATION TO BOILER

AUTOMATICALLY—ECONOMICALLY.

DESCRIPTION.

A—Hot Condensation Returns from Steam Traps, etc.
B—Hot Boiler Feed Make-up from Feed-Water Heater.
C—Collector into which all Hot Boiler Feed is received.
D—Connecting Pipe between Collector and Lifter, containing Stop Valve and Non-return Valve.
E—Lifter for elevating Feed Water into Feeder.

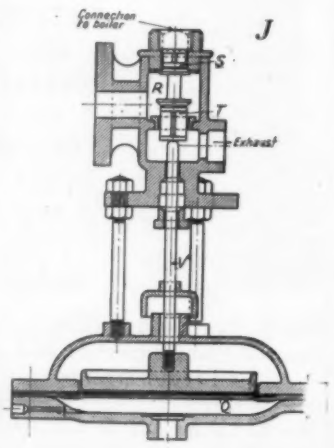


F—Steam Valve Chest for operating Lifter.
G—Non-return Valve through which Feed Water passes to feeder H.
H—Feeder placed well above Boiler as shewn.
J—Diaphragm and Valve for controlling Steam operating Feeder and regulated by pressure in Lifter E.
K—Non-return Valve between Feeder and Boiler.

HIGH TEMPERATURE FEED!

NO OIL USED! ALL EXHAUST STEAM RECOVERED!

The illustration shows a typical fixing arrangement.



These Sections of the Valve Boxes "F" and "J" show the simple character of their construction and accessibility for repair.

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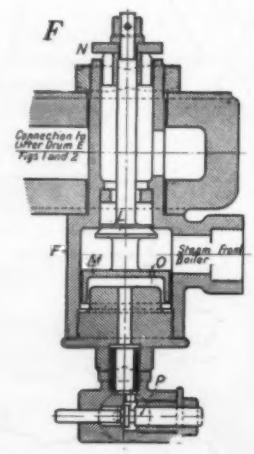

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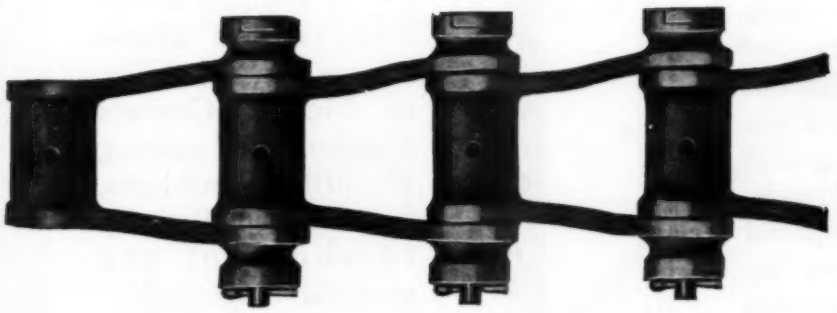

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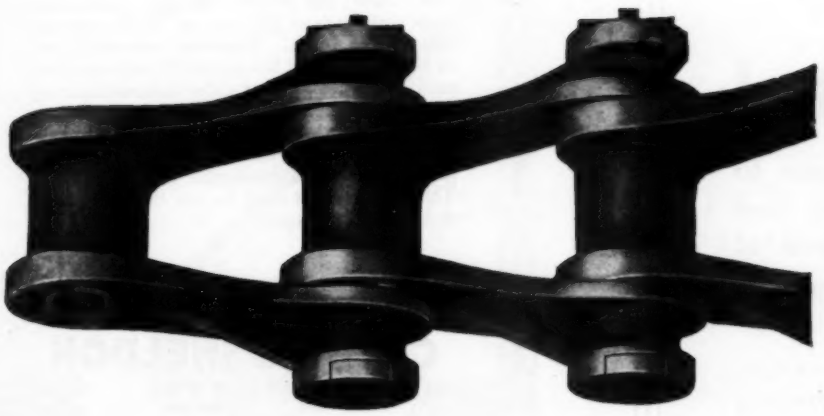
Working Loads up to 3,500 lbs. Are regularly used for drives running not faster than 400 feet per minute, and for Elevators of medium capacity.



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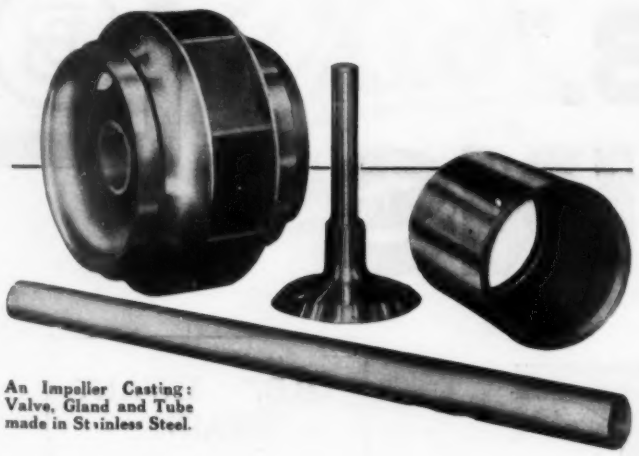

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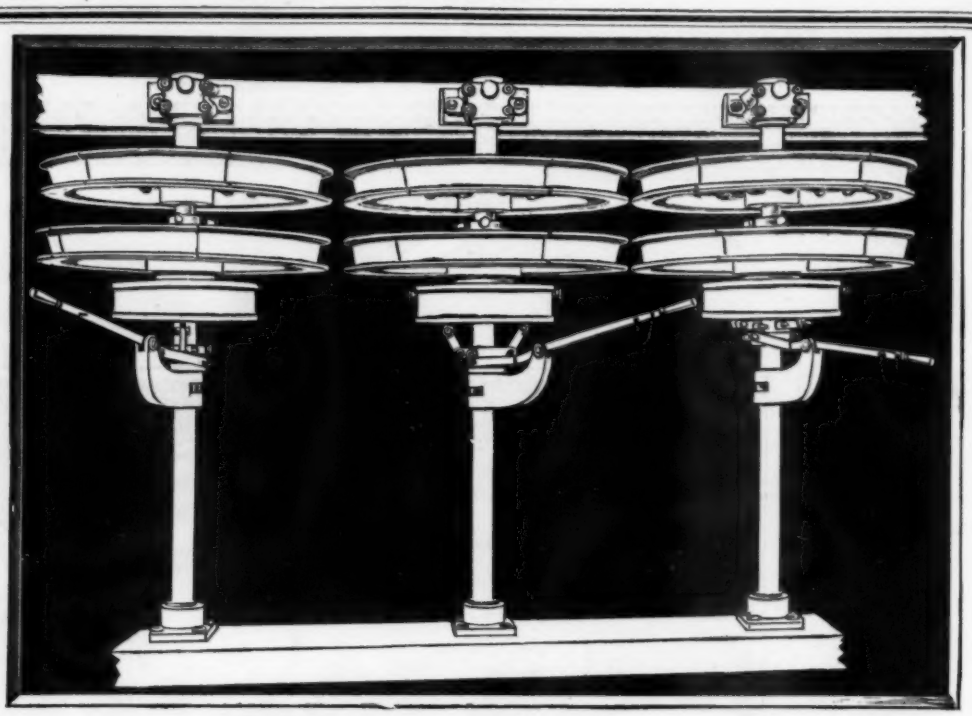

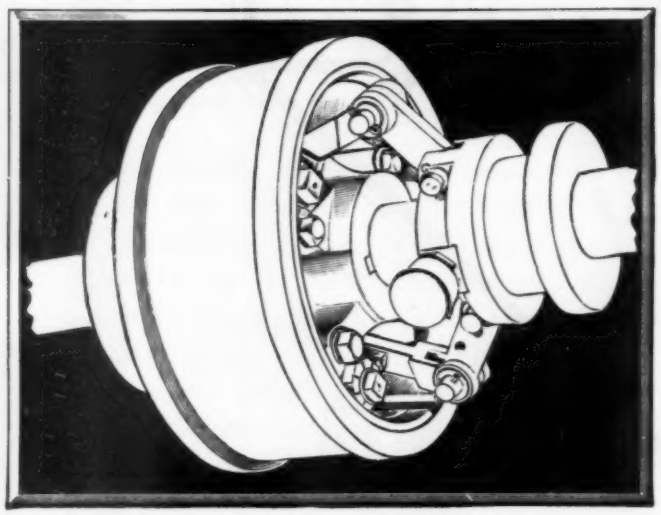

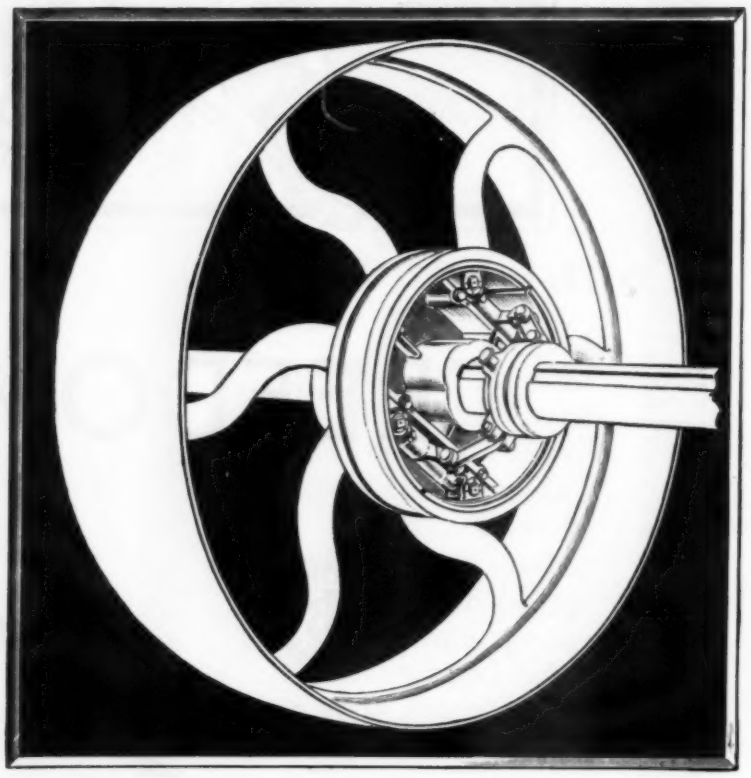

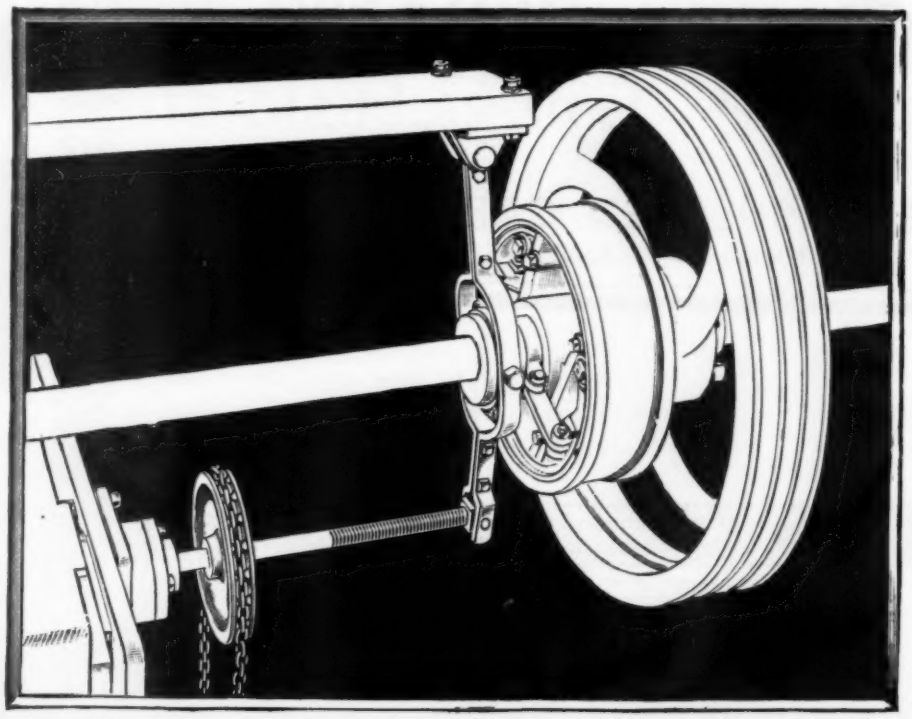

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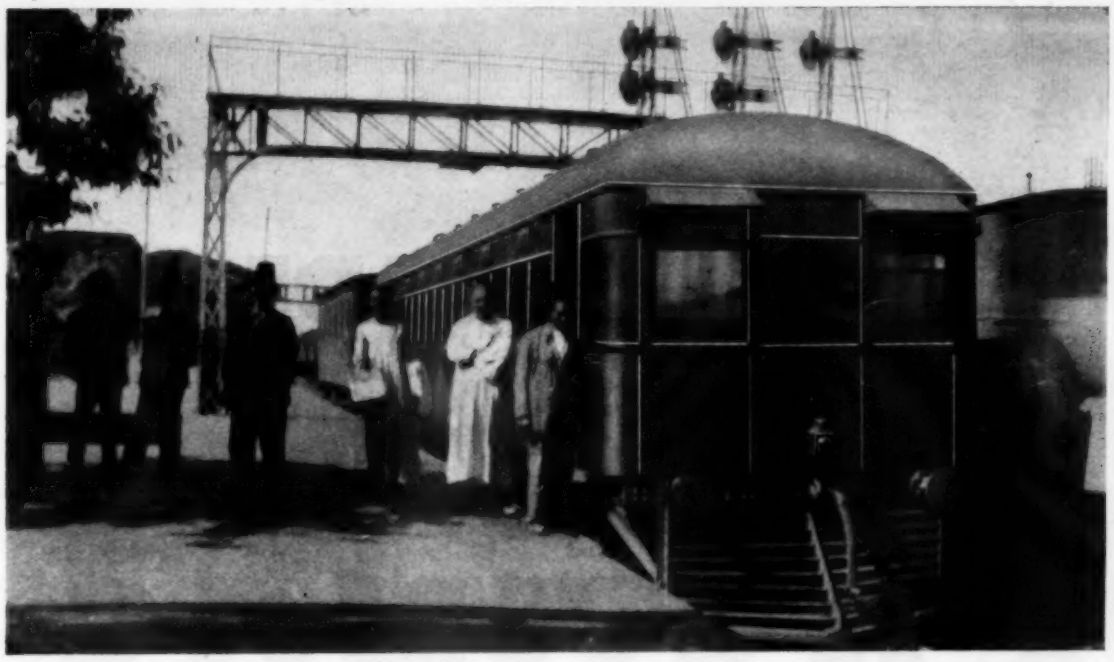

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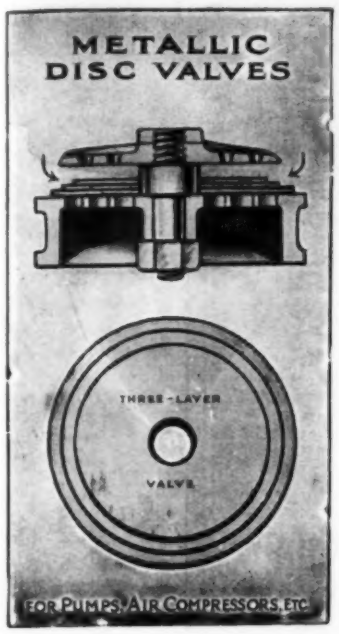

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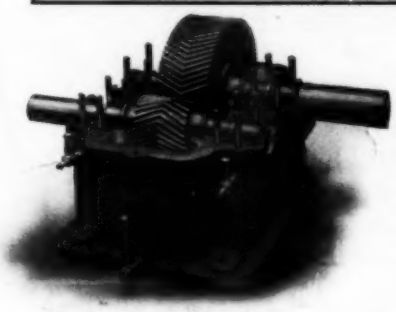

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1880
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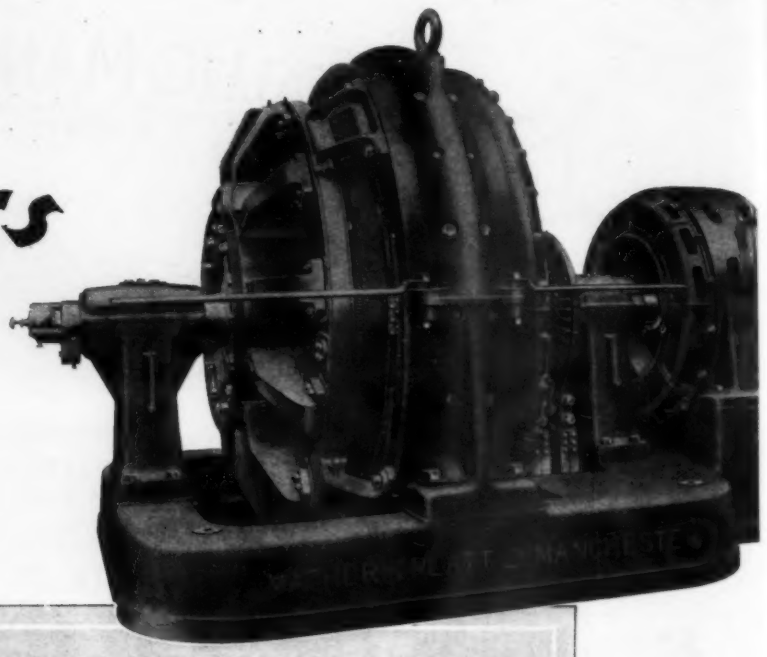

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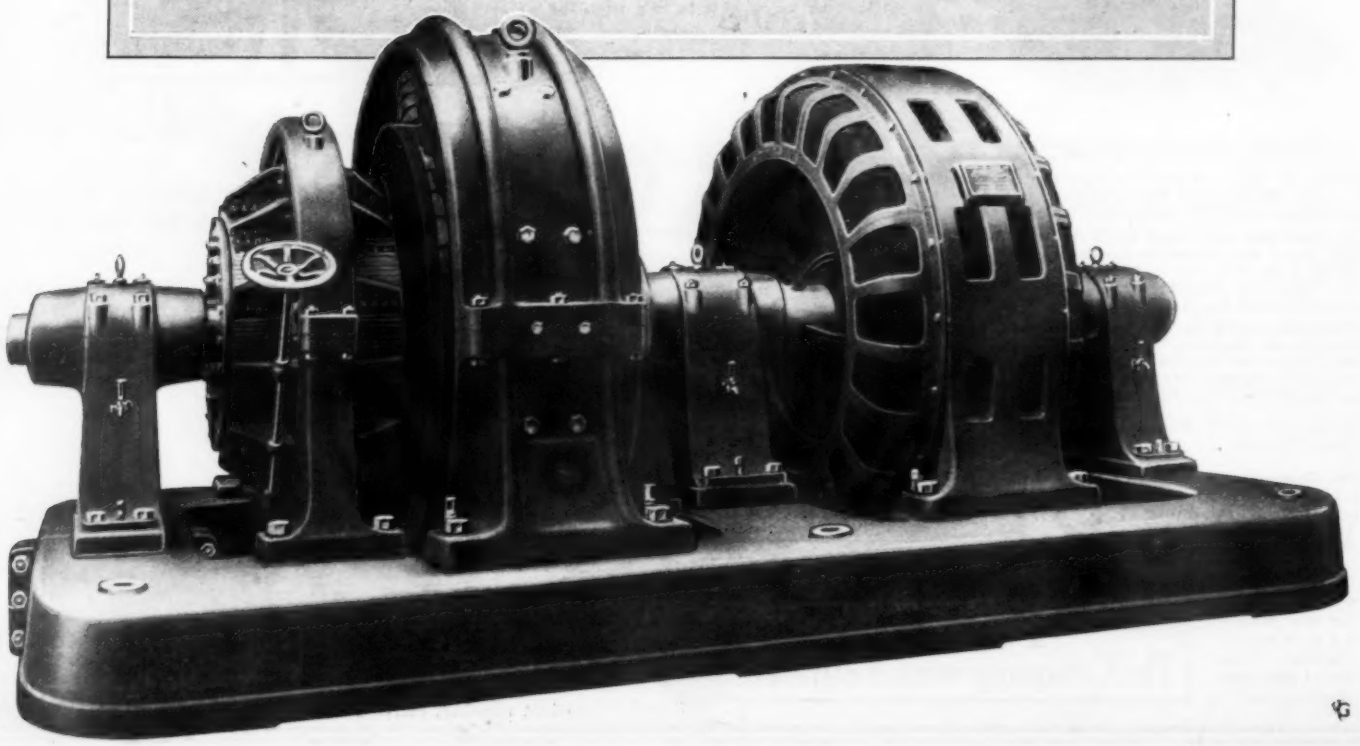

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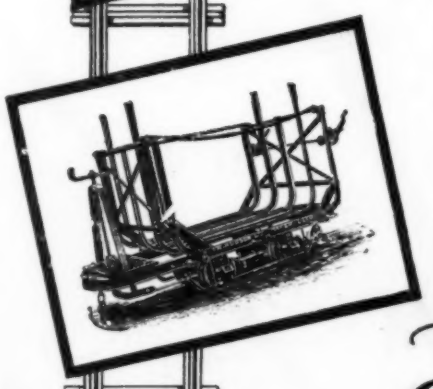

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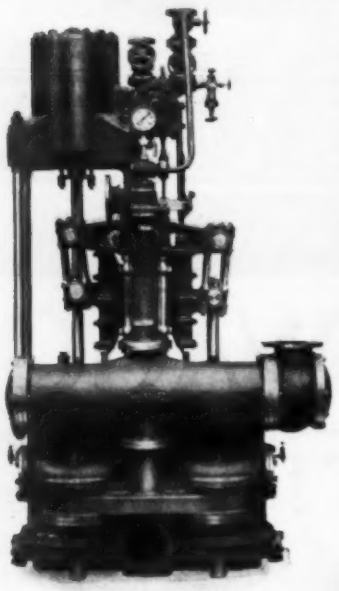

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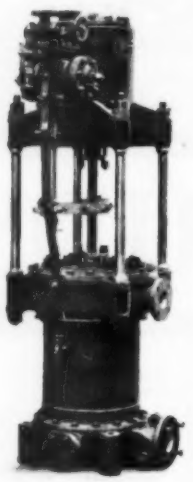

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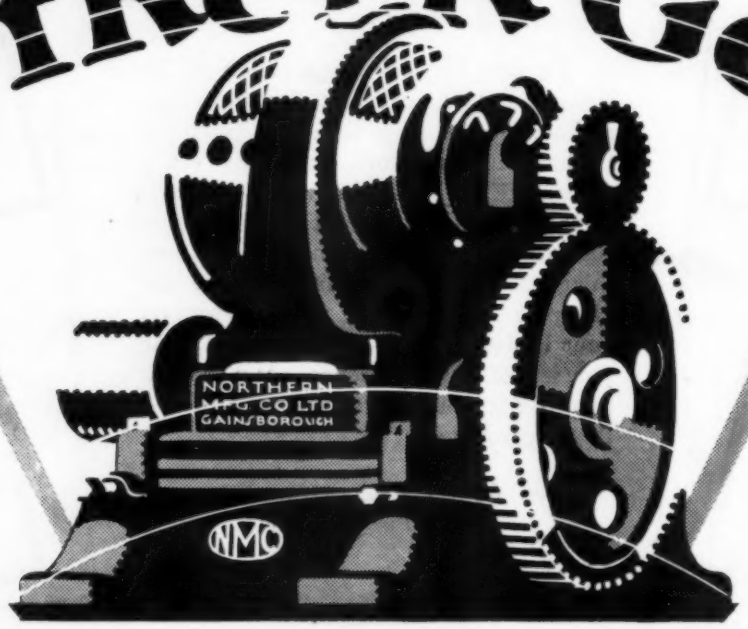

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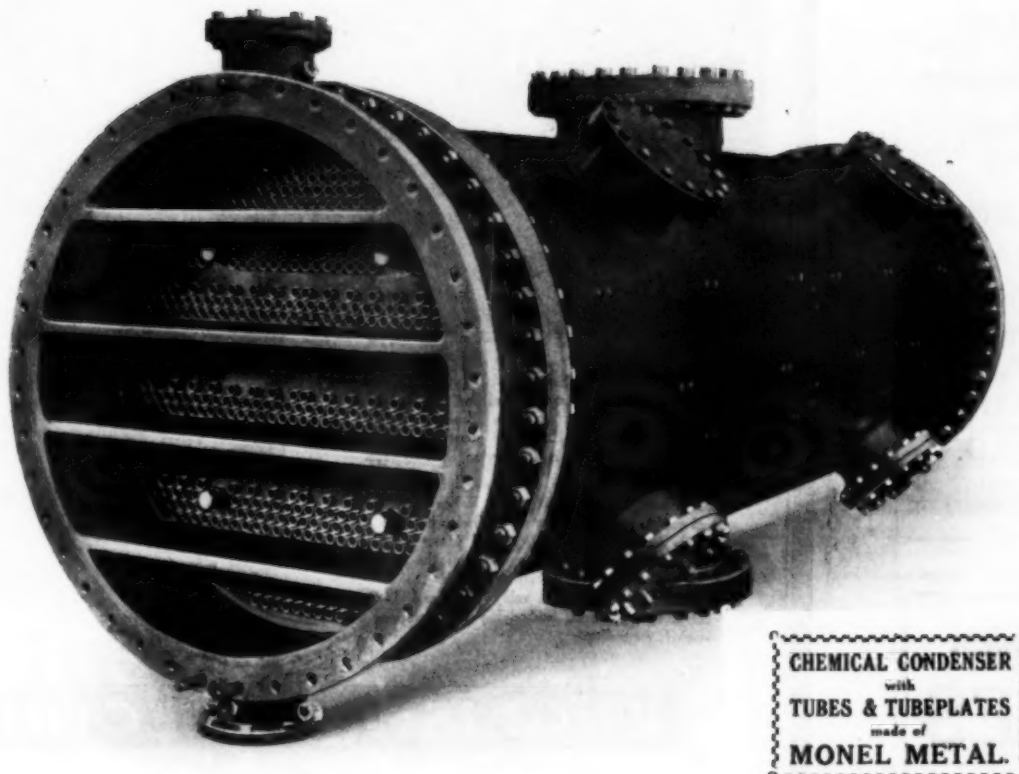

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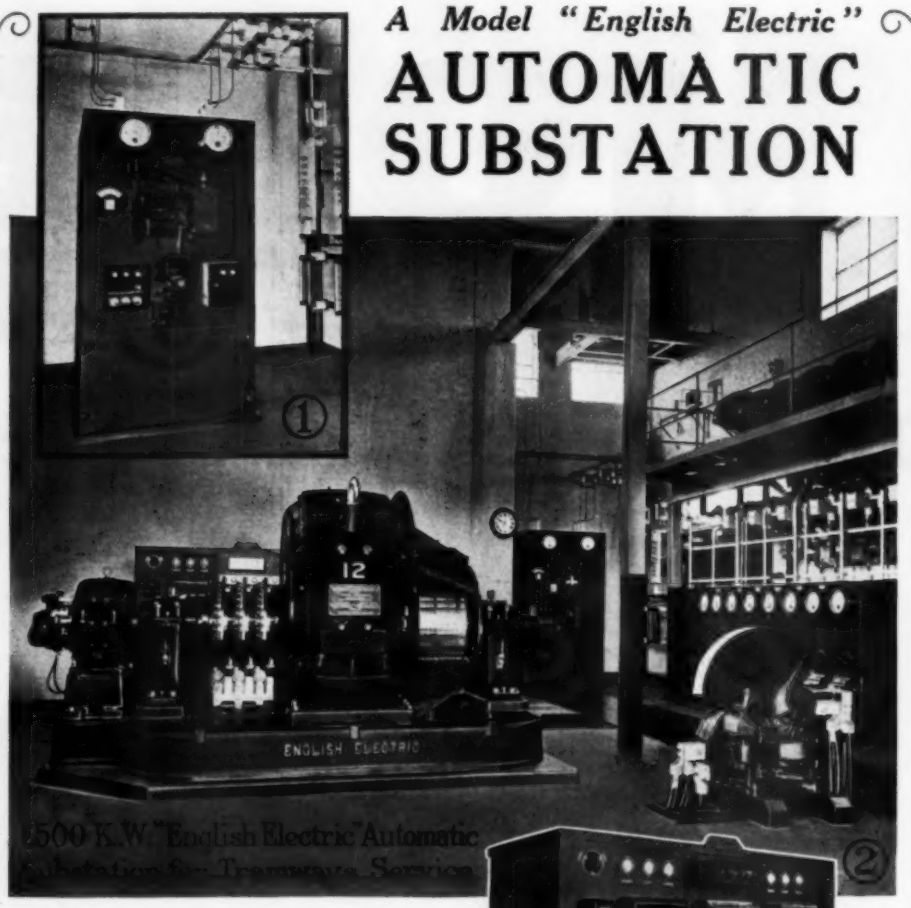

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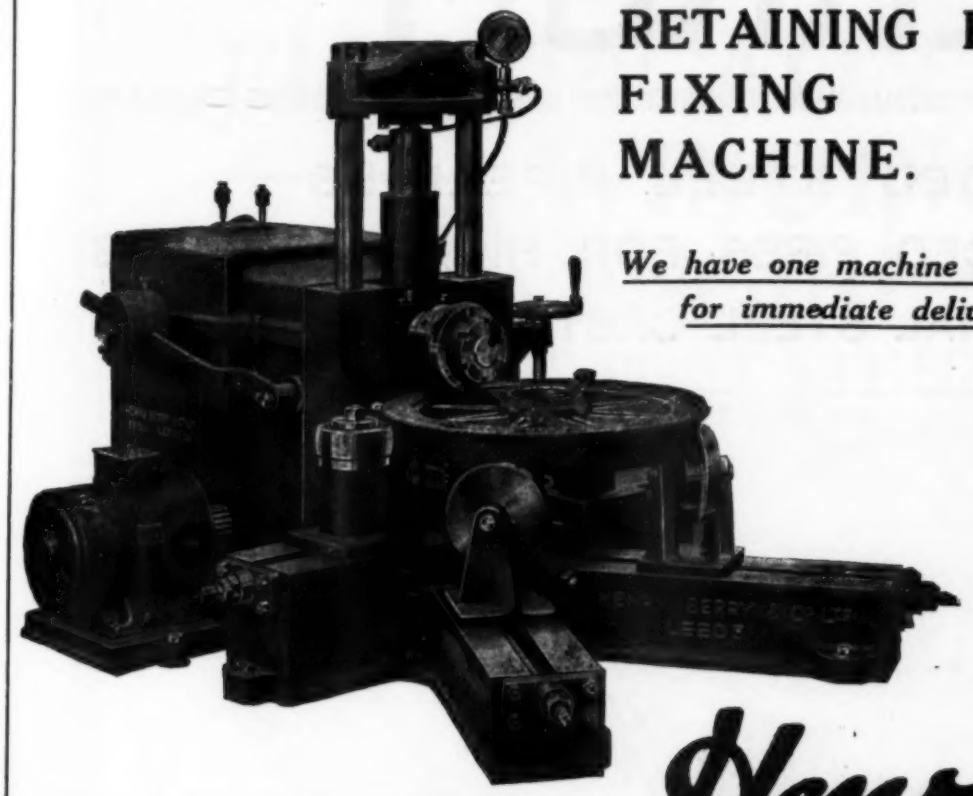

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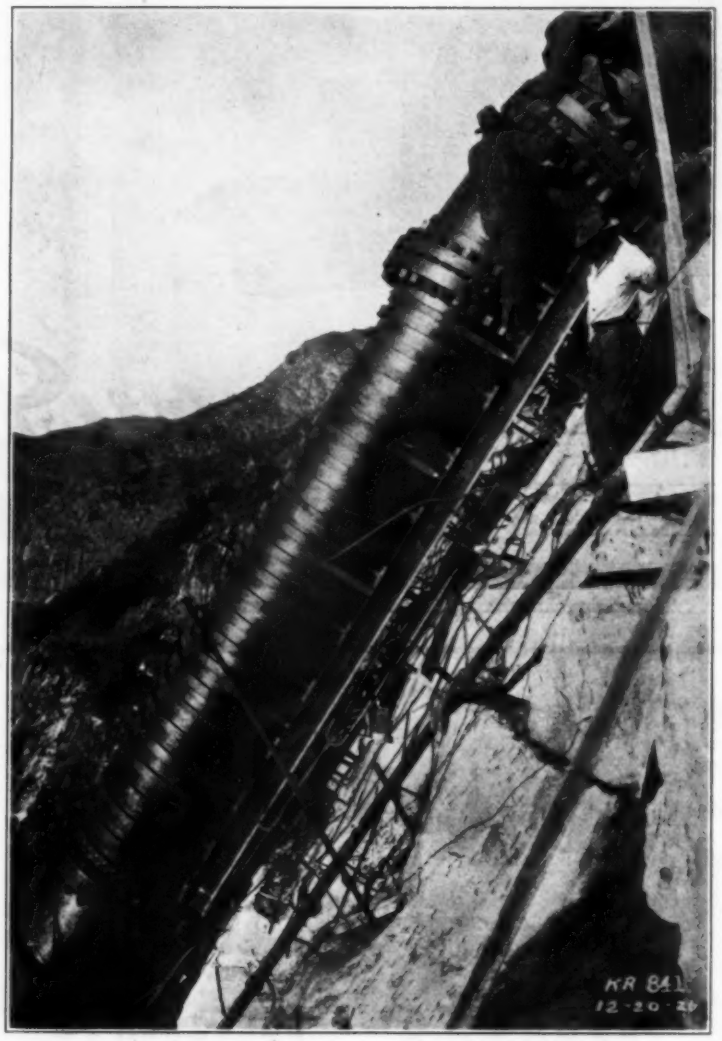

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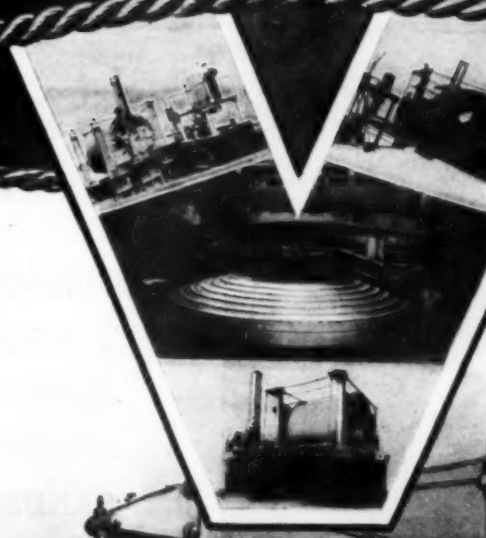

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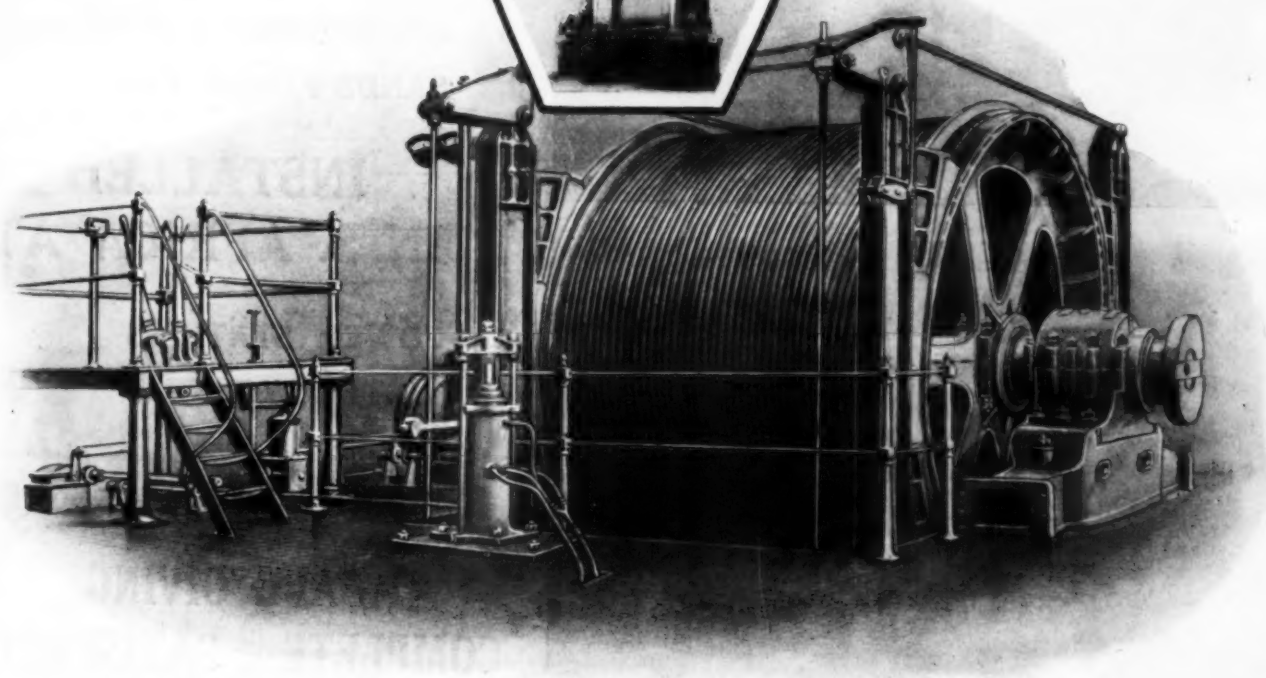

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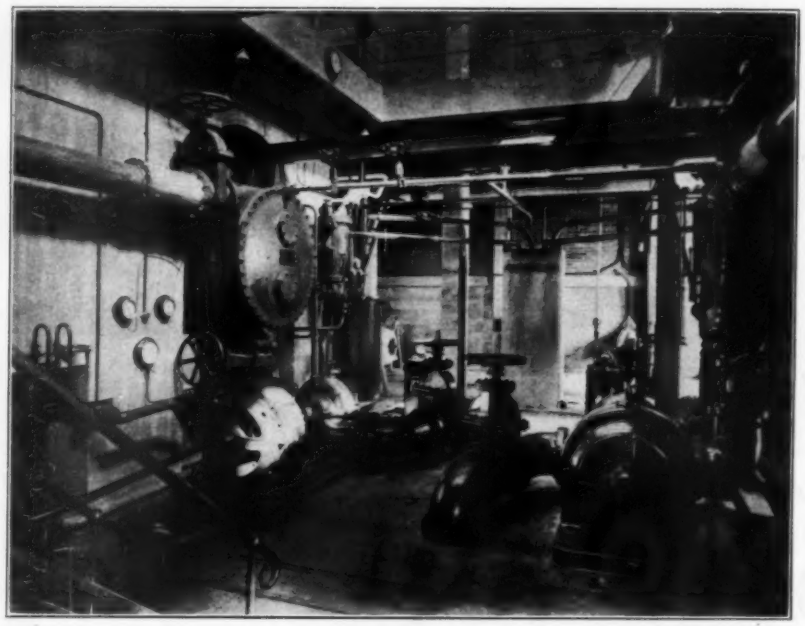

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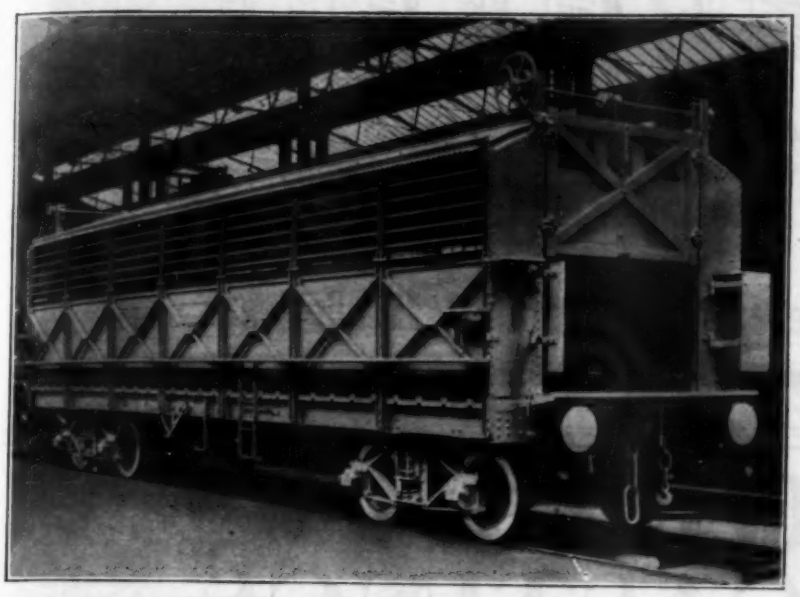

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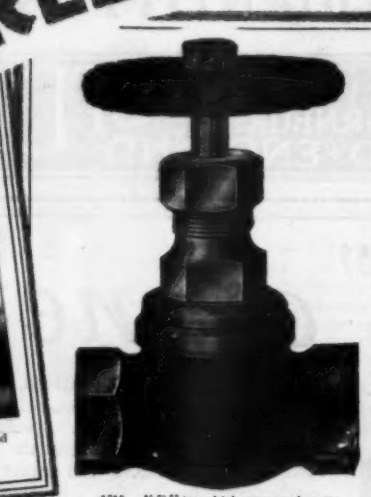

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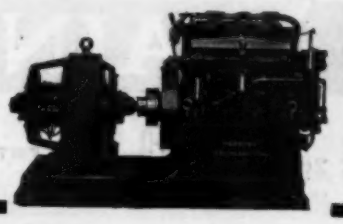

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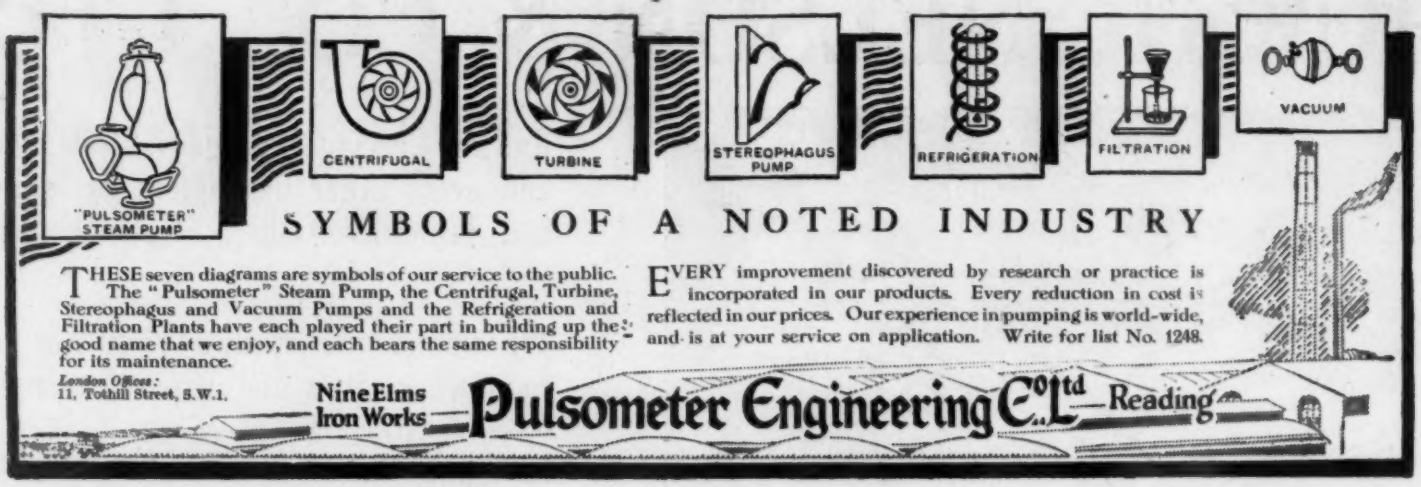

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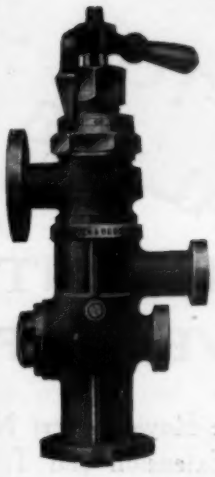

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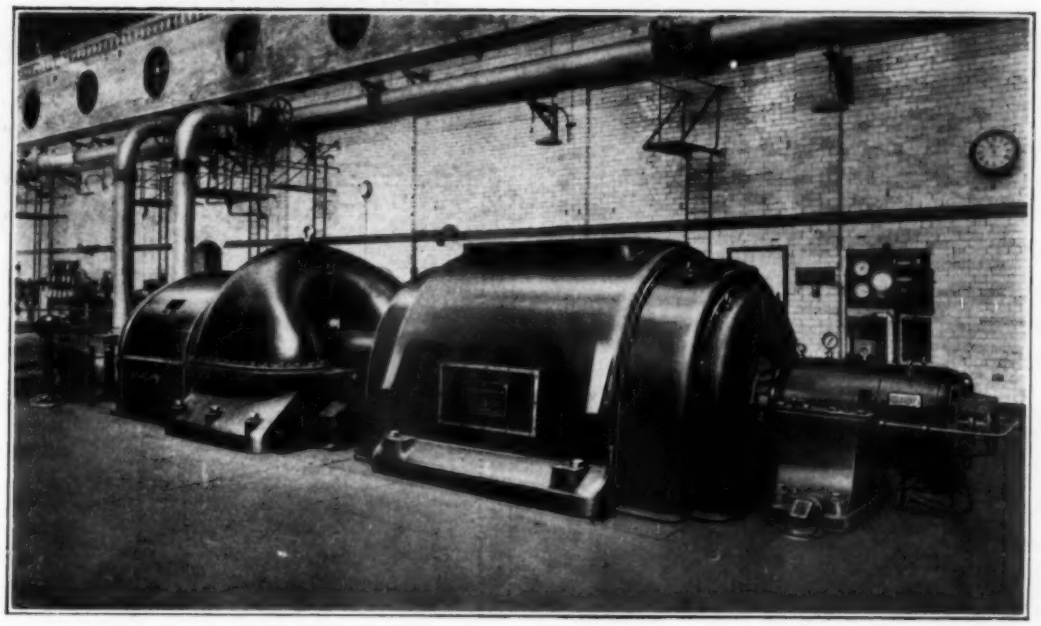

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The Crompton Parkinson organisation is specially qualified for the construction and installation of plant to suit local requirements, particularly where difficulties of operation are encountered and where intricate construction of plant is essential to correct and economical application.

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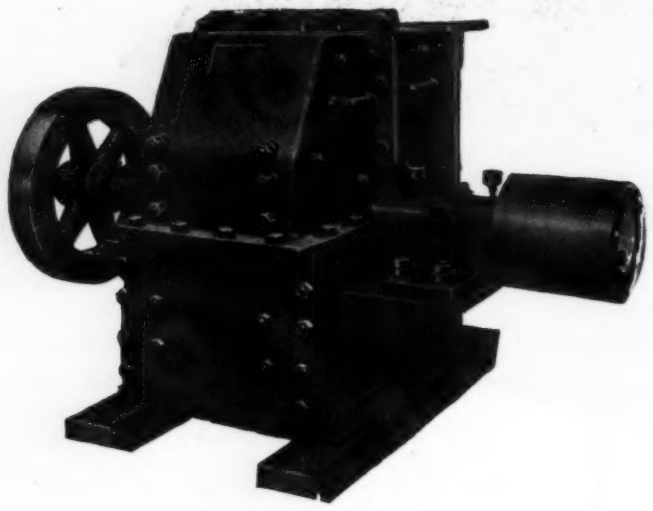
the all-steel hammer mill



THE K-B PULVERIZER.

EDGAR ALLEN & CO., LIMITED, have been appointed sole licensees and manufacturers for Great Britain of the K-B Pulverizer. This is an all-steel hammer mill for pulverizing moderately hard materials. It is specially suitable for the following:—

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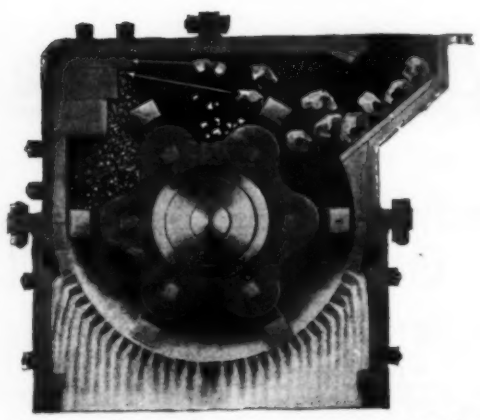
Advantages of the K-B Pulverizer.

1. It takes a larger piece and crushes it to a finer product than any other single machine. In some cases it eliminates the work of the preliminary crusher; in other cases it does away with additional screens and separators.

2. Both the initial and also the operating cost of a hammer mill are less than those of most other types of reduction machinery. This is because it is simpler in construction and consumes less power when doing similar work.

3. The K-B Pulverizer will often handle wet or damp materials, thus eliminating the cost of drying before pulverizing.



ILLUSTRATING INTERIOR OF K-B PULVERIZER WHILE IN OPERATION.

Capacity and power of the K-B Pulverizer.

The table opposite gives only approximate figures of the capacity and power of the K-B Pulverizer, because these vary considerably according to the hardness of the material, its moisture, size of feed, etc. On receipt of a small sample of material, Edgar Allen & Co., Ltd., will gladly give more exact figures.

APPROXIMATE CAPACITY.

	Size of Product. 90-100 per cent. passing.			Approx. Power.
	¼"	10 mesh	20 mesh	
	Tons per hour.	Tons per hour.	Tons per hour.	H.P.
K-B No. 1				
Stone	4-7	3-6	2-5	12-15
Coal	6-9	5-8	3-6	12-15
Lime	10-13	9-12	6-9	12-15
K-B No. 2				
Stone	12-15	11-14	7-10	25-30
Coal	16-19	15-15	11-14	25-30
Lime	20-24	18-24	13-18	25-30
K-B No. 3				
Stone	27-36	22-27	18-22	50-60
Coal	40-50	30-40	22-32	50-60
Lime	45-54	36-45	27-36	50-60

Speed: 1,000 revs. per minute.

How to test the K-B Pulverizer.

Those interested can test the K-B Pulveriser by sending a sample of their material for trial in this machine at the Imperial Steel Works, and can attend these trials in person. Packages should be clearly labelled with the name of the sender, and should be consigned Edgar Allen & Co, Limited, Machinery Department, West Tinsley Sidings, L. M. & S. or L. & N.E. Railway.

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To Edgar Allen & Co. Ltd. Imperial Steel Works, Sheffield.

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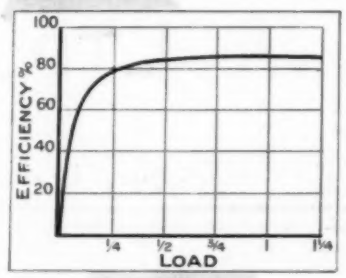
Points Engineers look for in Motor Design-

No.1

Efficiency

High Efficiency pays a dividend



The motor that is low in price is often low in efficiency, a point that should not be disregarded.

Efficiency is a very significant characteristic and its value ought always to be reckoned in with the initial cost of the motor.

The adjoining curve gives efficiency values at various loads of a 10 h.p. 965 r.p.m. "Metrovick" Type "S" Motor. For a year of 2,500 hours at a mean load of 7½ h.p. and 1d. per unit the total cost for power would be £66. 12s. 0d.

In comparison, a motor with an 82% efficiency would cost for the same period £70. 12s. 0d. Thus the high efficiency motor pays a quarterly dividend of £1, and in some cases this represents the recovery in 12 months of an extra cost of 25%.

The engineer is satisfied with the efficiency of "Metrovick" Type "S" Motors.

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TRAFFORD PARK ··· MANCHESTER

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SHOVEL STOKER

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Increased Steam Production.
Smoke Abatement.

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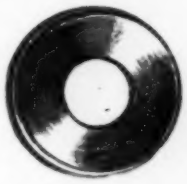

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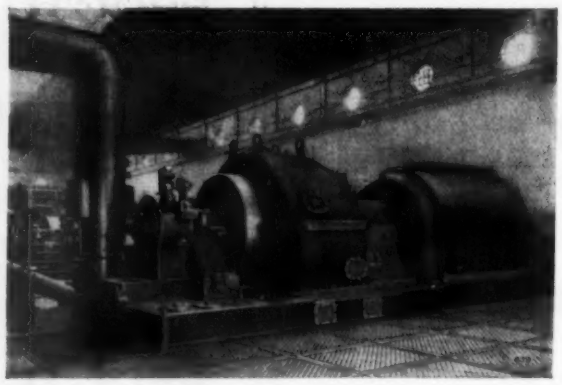

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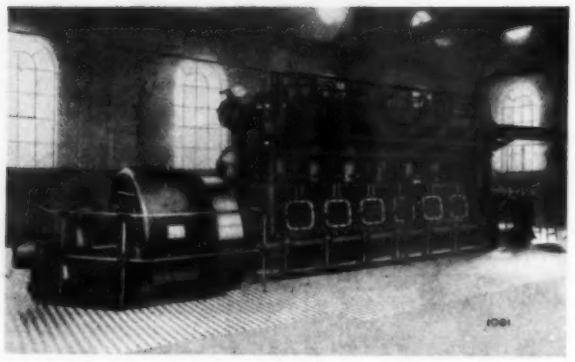

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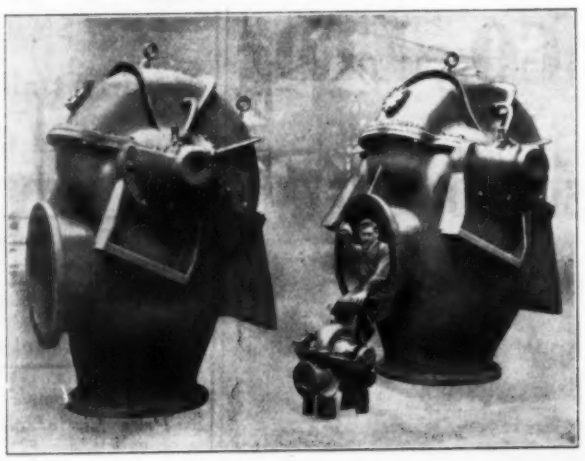

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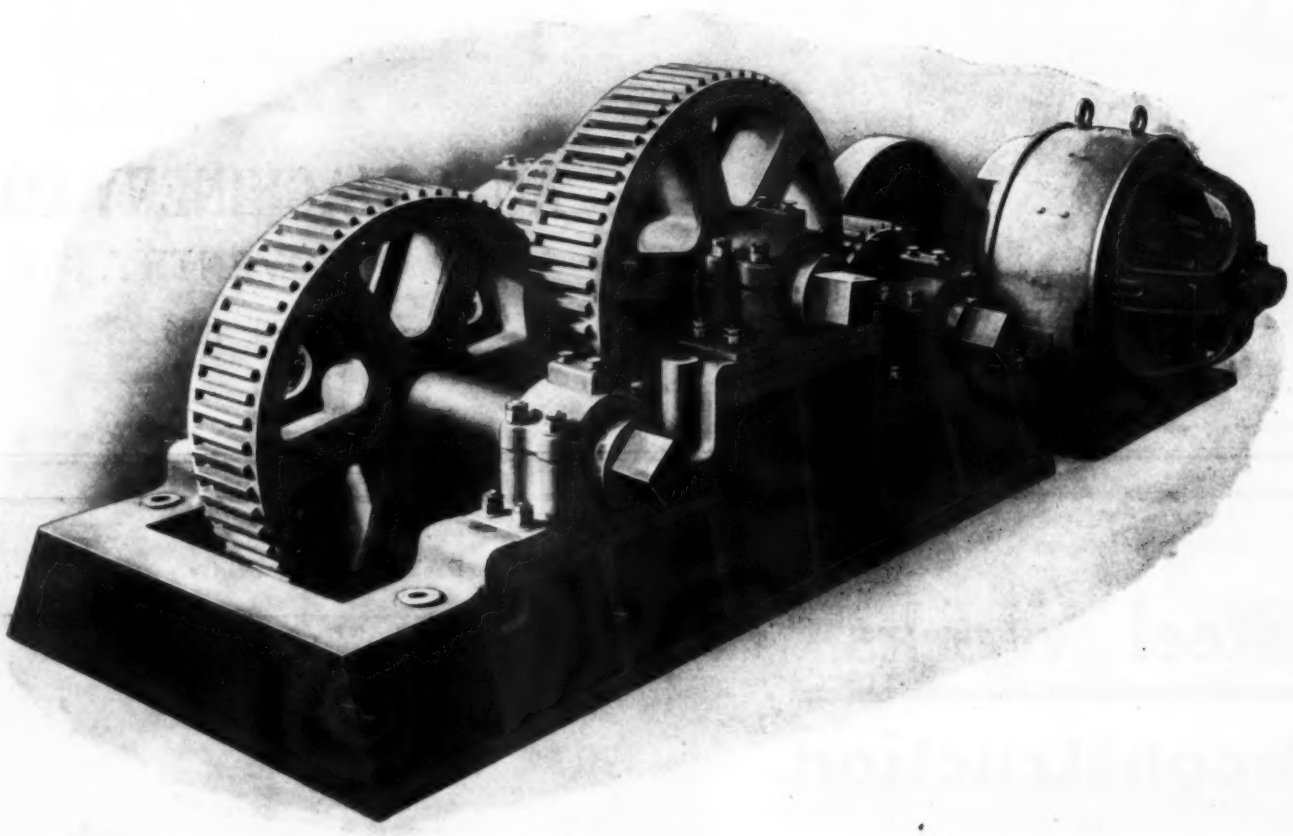

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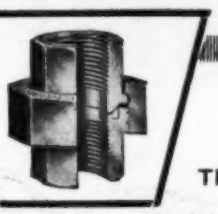

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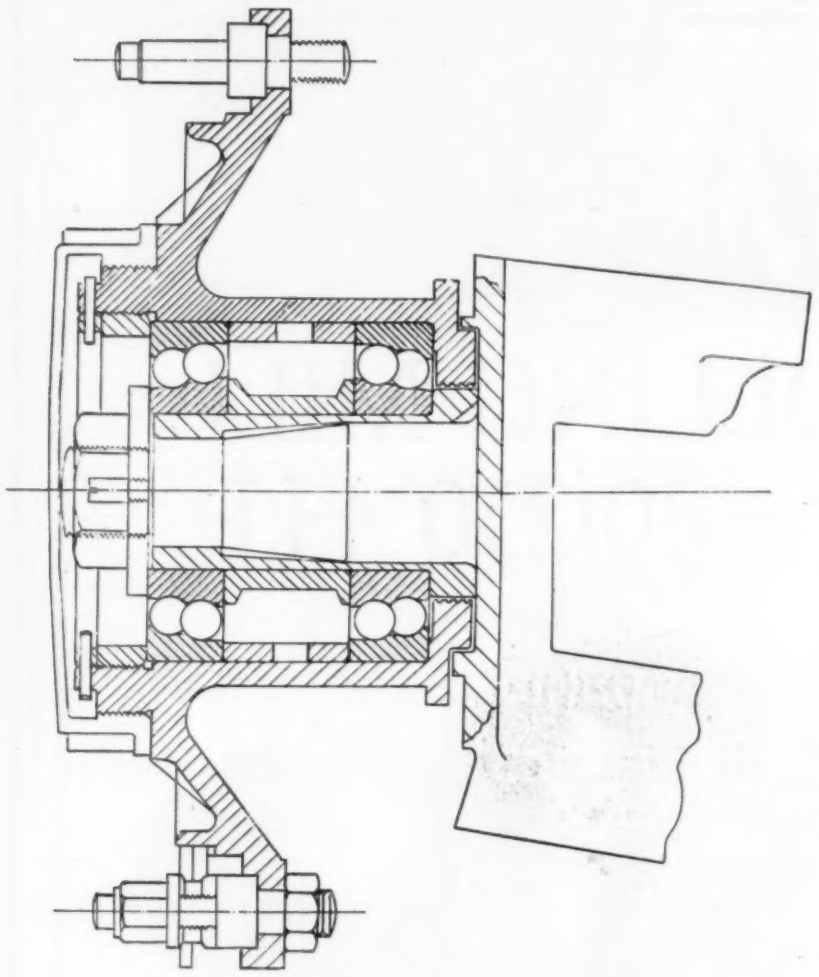

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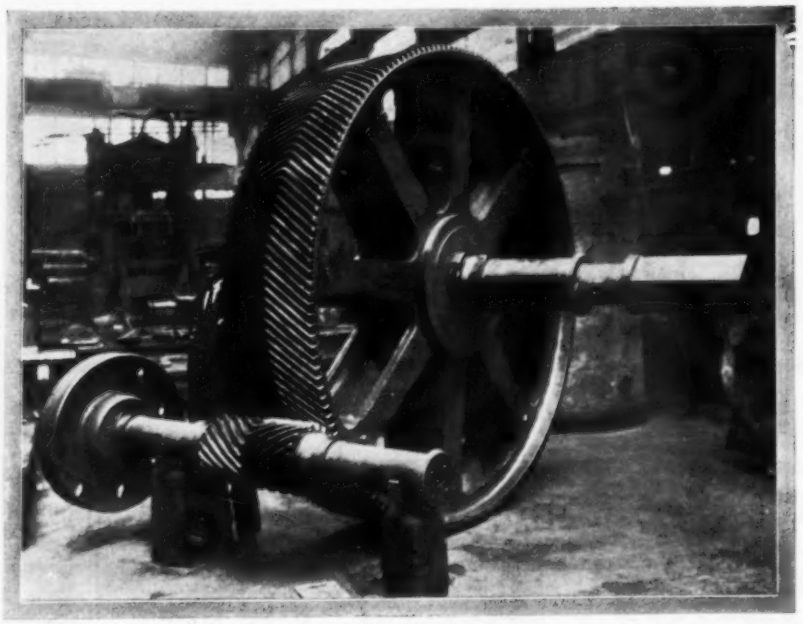

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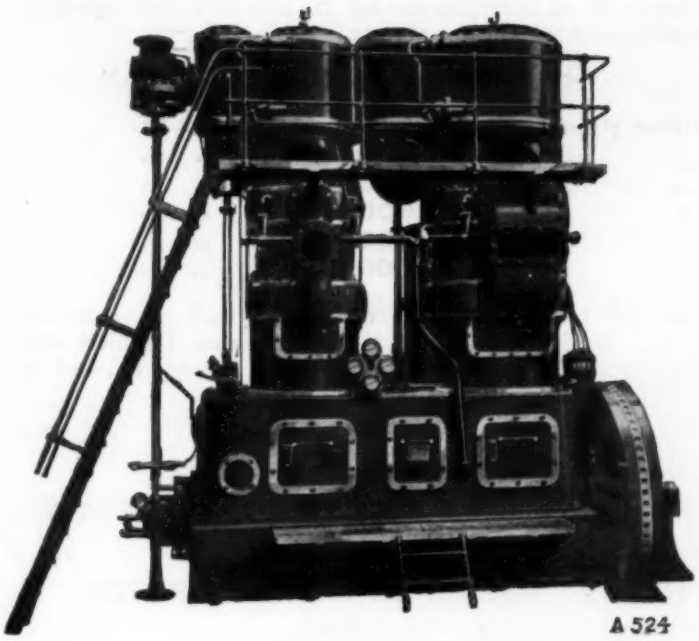

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Metal Tested:	Pressure at Time of Destruction.	Ran
Magnolia	2000 lb. per sq. in.	80 min.
A	1400 ,, ,,	10
B	1400 ,, ,,	5
C	1400 ,, ,,	3 Fused
D	1200 ,, ,,	10
E	1200 ,, ,,	6
F	1200 ,, ,,	5
G	1200 ,, ,,	5
H	1200 ,, ,,	3
I	1000 ,, ,,	15
J	1000 ,, ,,	10
K	1000 ,, ,,	5
L	1000 ,, ,,	2
M	800 ,, ,,	10 Fused
N	700 ,, ,,	12 Fused
O	600 ,, ,,	12
P	500 ,, ,,	40 Fused
Q	500 ,, ,,	30 Fused
R	500 ,, ,,	28
S	500 ,, ,,	25

Magnolia was the only metal remaining in good working condition at the end of the test.

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20 ,, ,, ,, ,, 1200 ,, ,, ,, ,,
10 ,, ,, ,, ,, 1400 ,, ,, ,, ,,
10 ,, ,, ,, ,, 1600 ,, ,, ,, ,,
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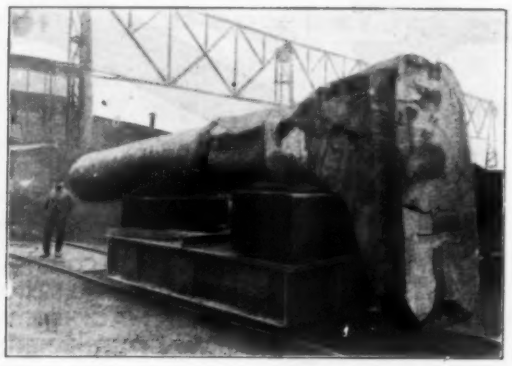

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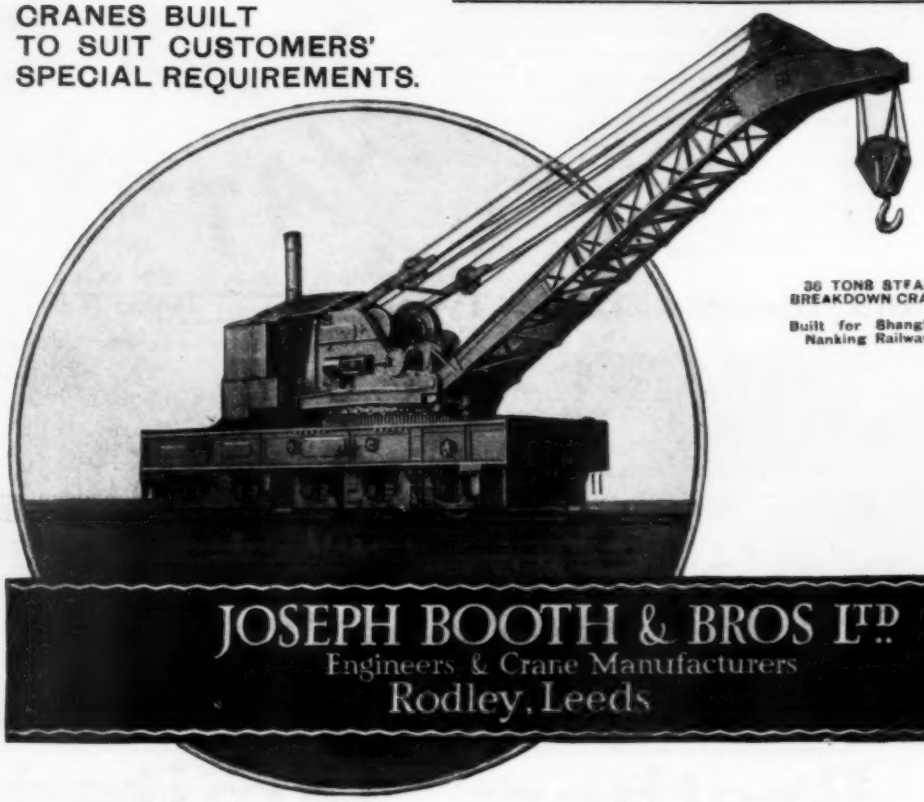

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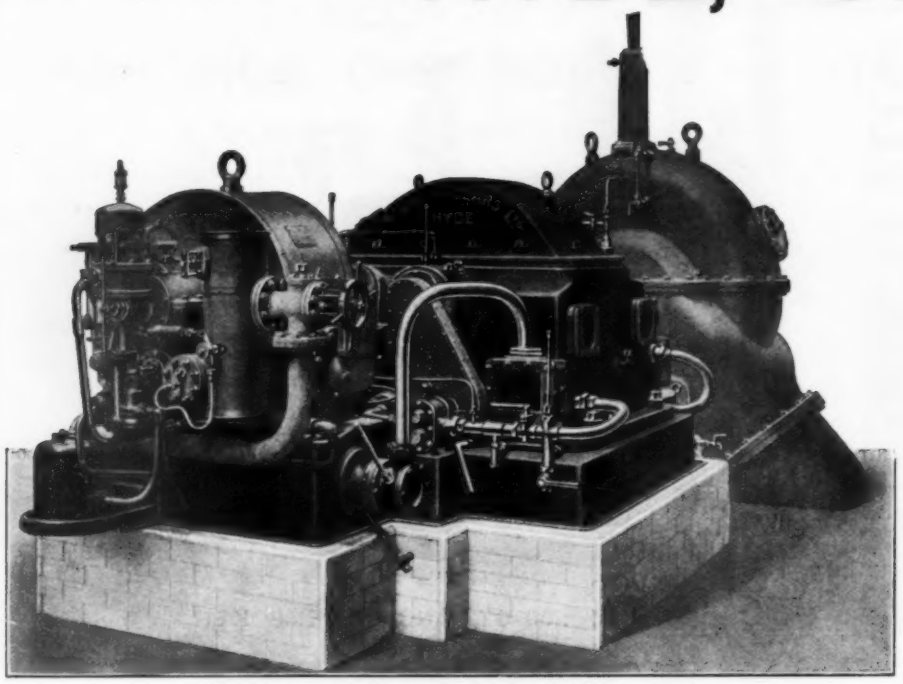

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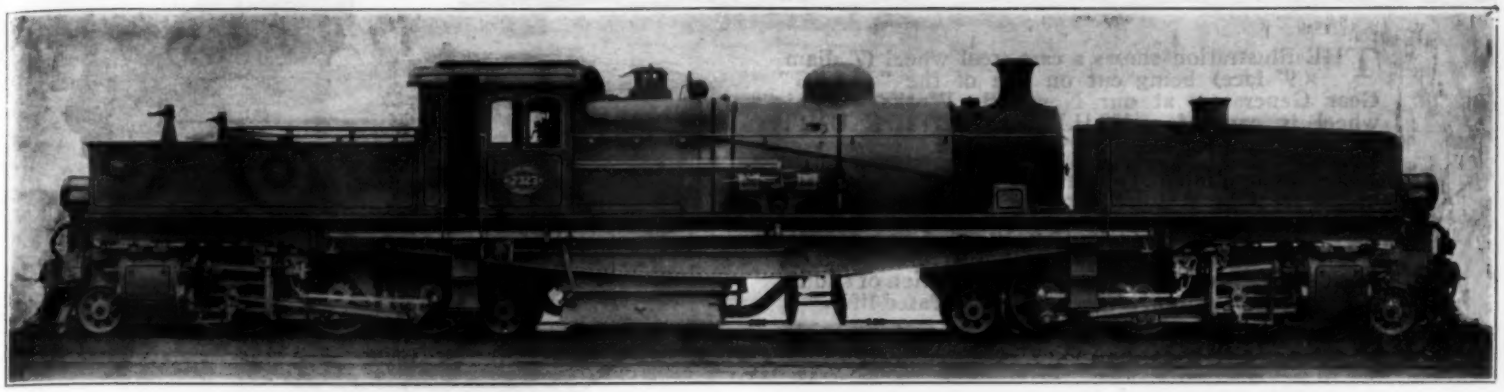
(N. B. L. Co.'s Patents.)



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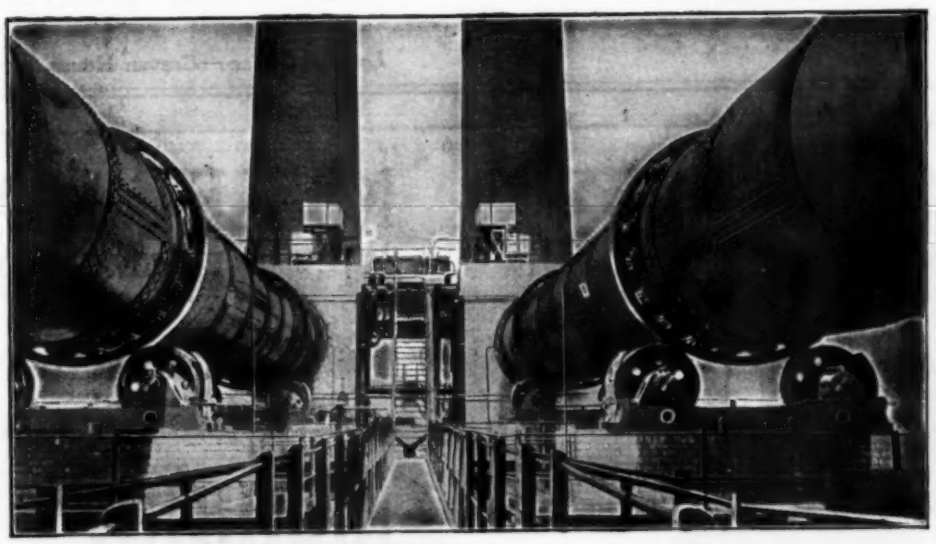

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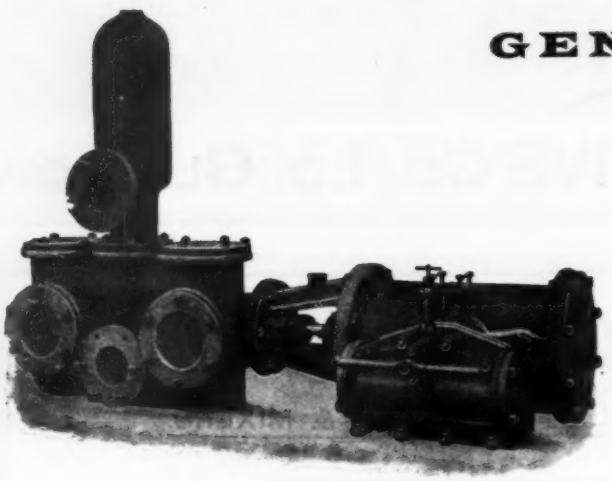

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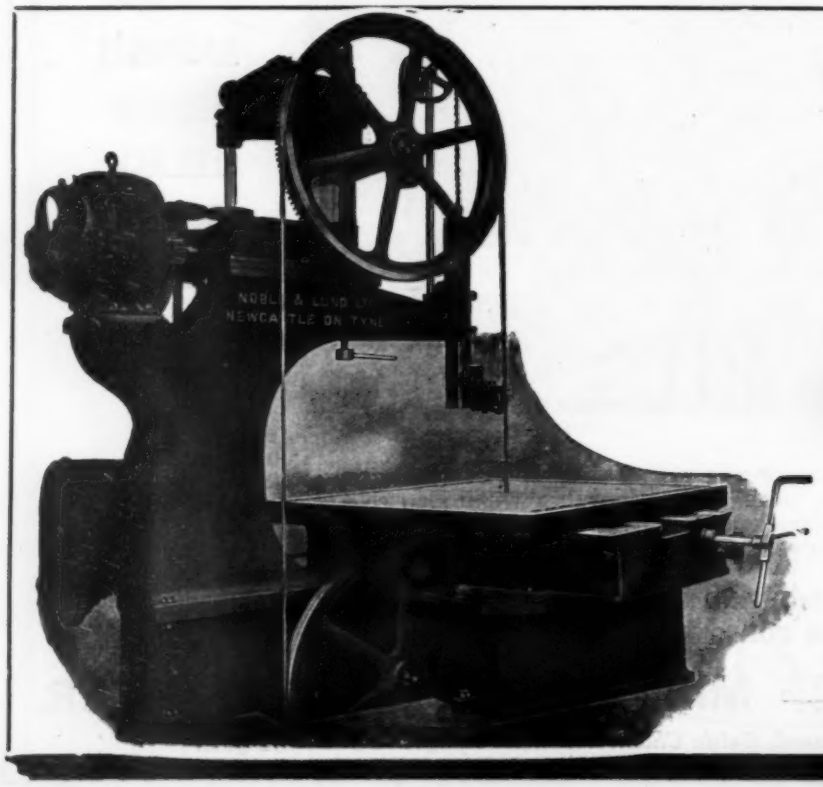

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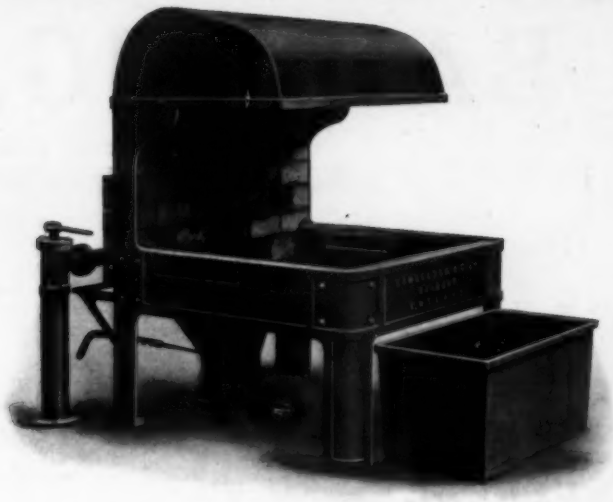

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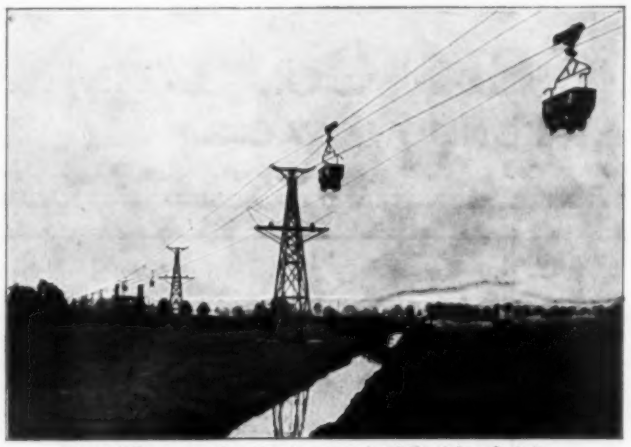

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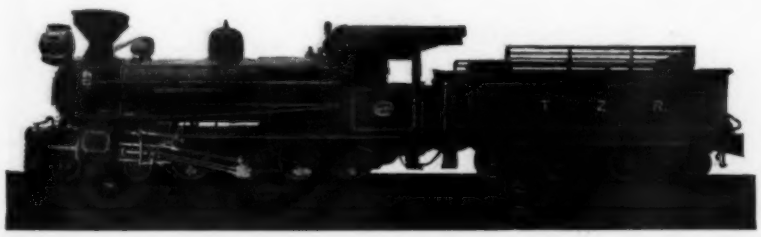

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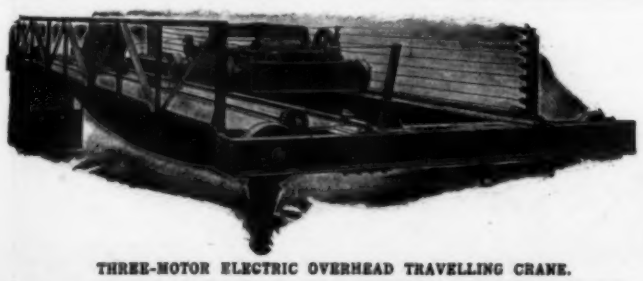

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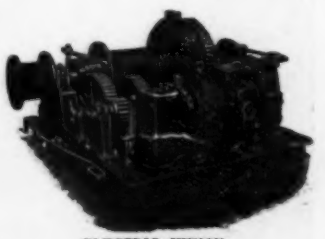

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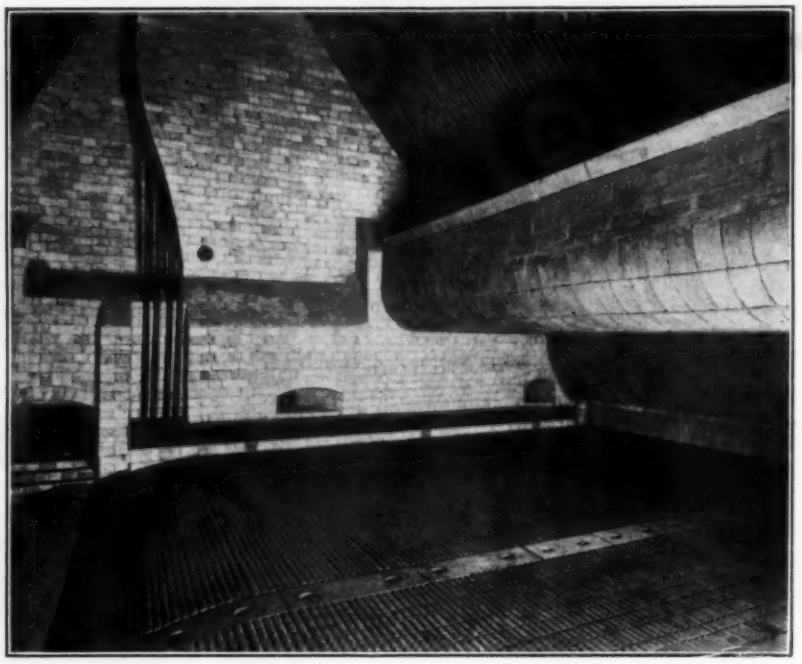

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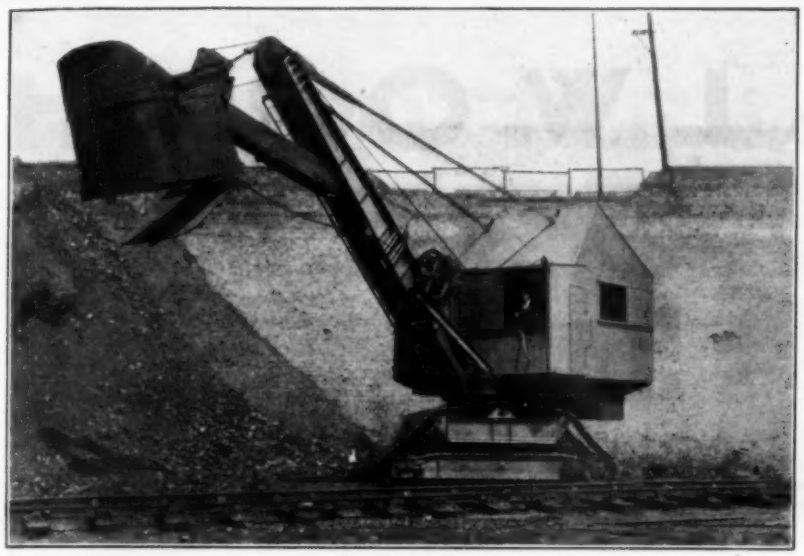

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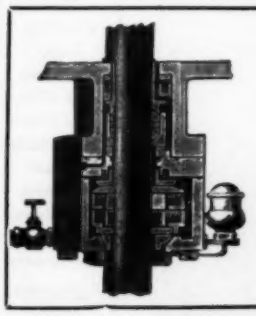

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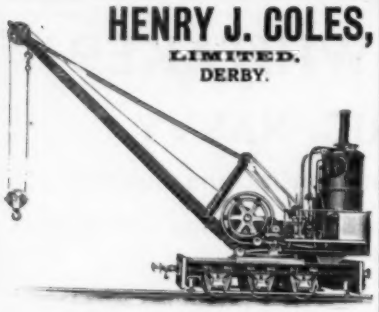

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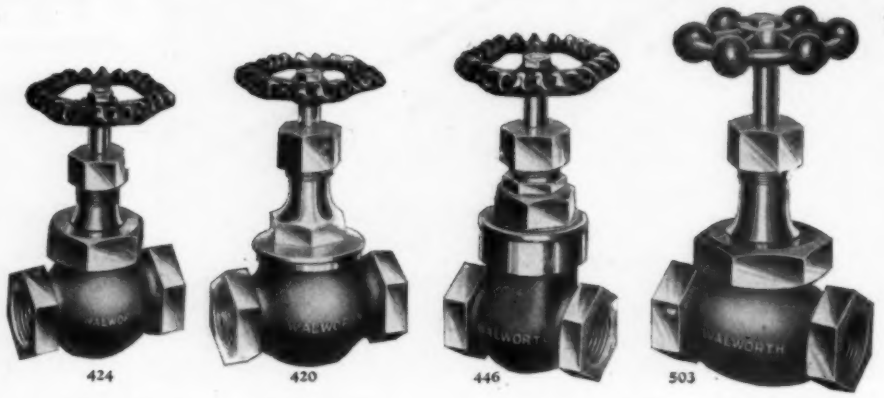

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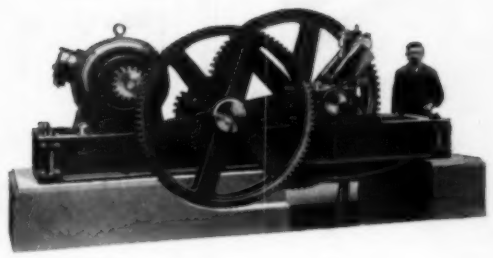

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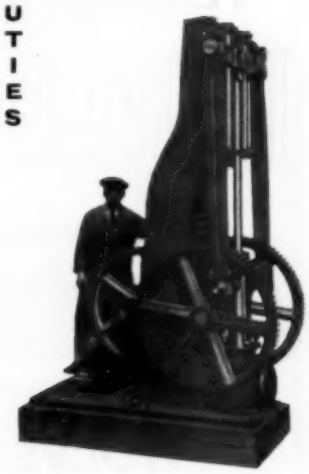

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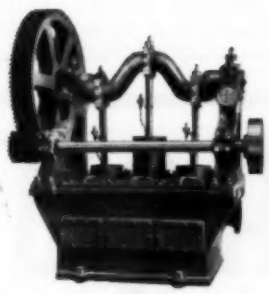

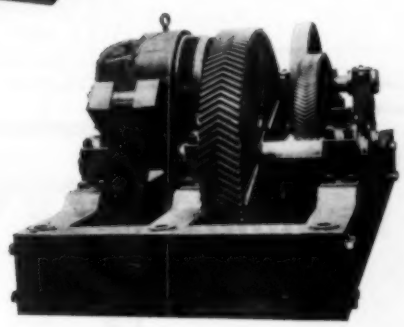

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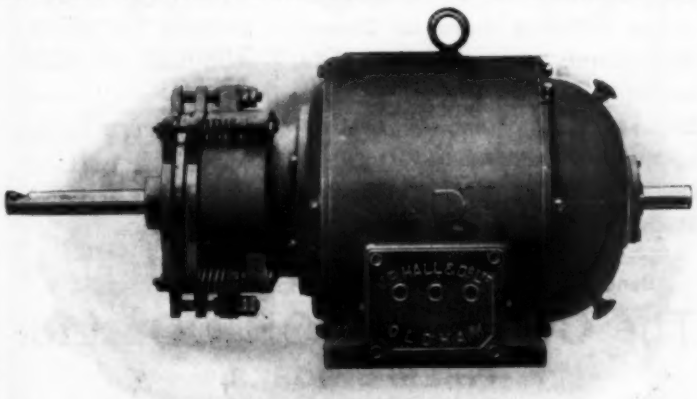

Fig. 471a.

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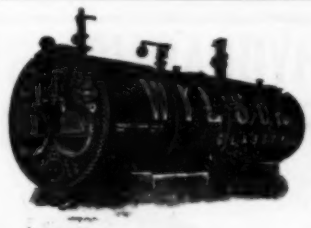

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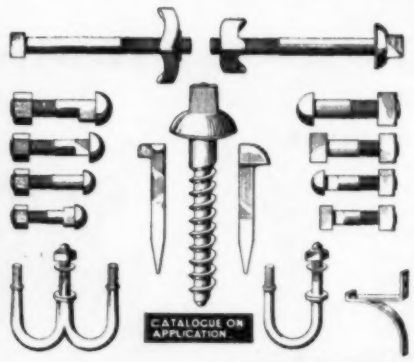

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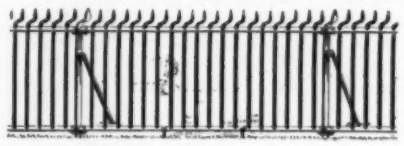

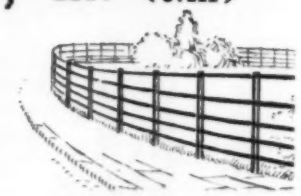

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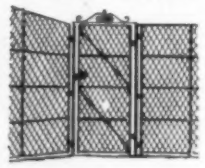

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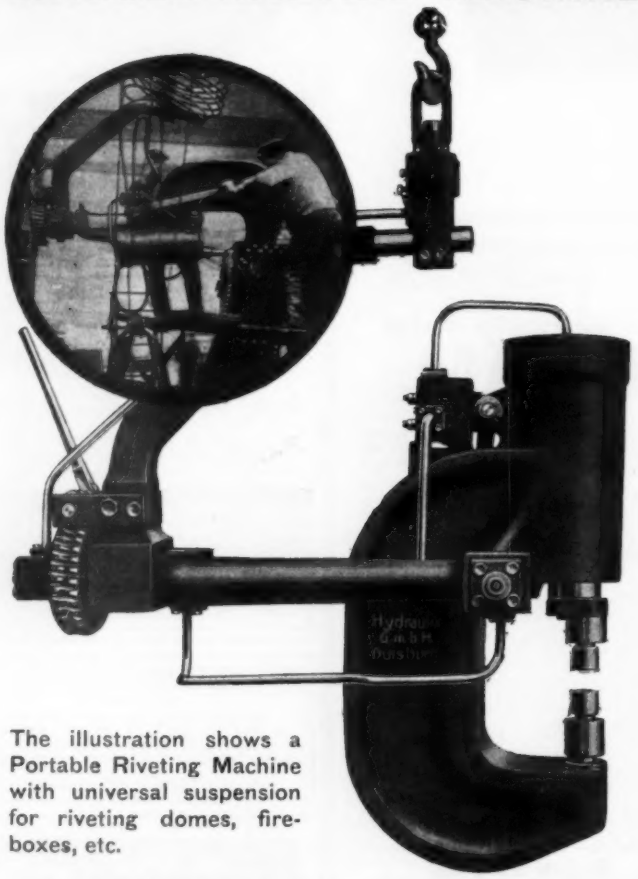

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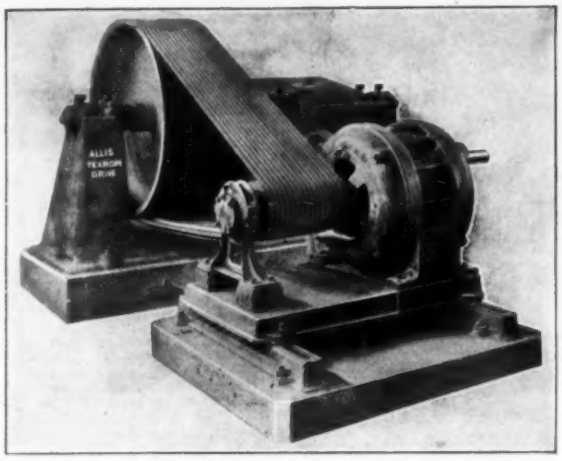

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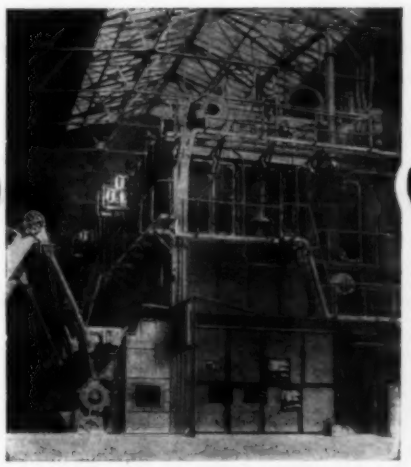

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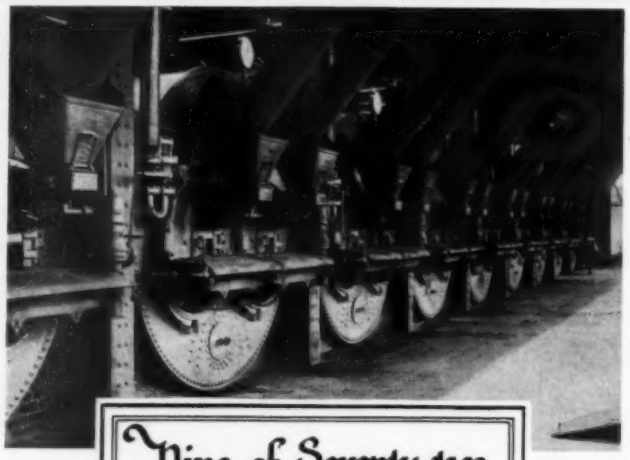

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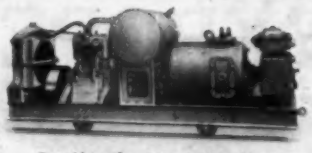
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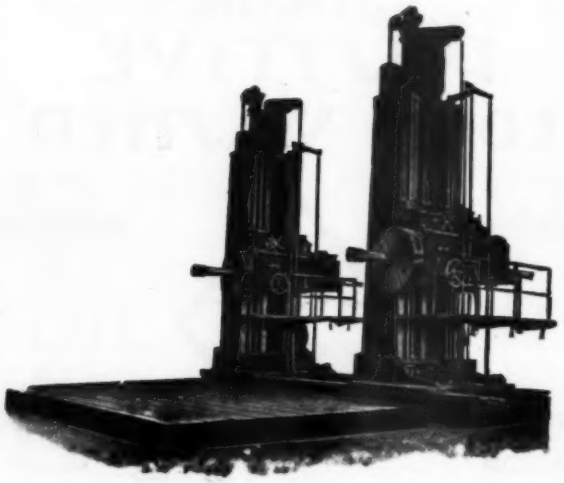
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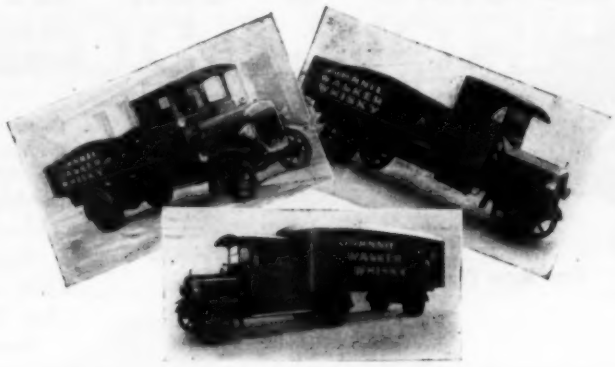

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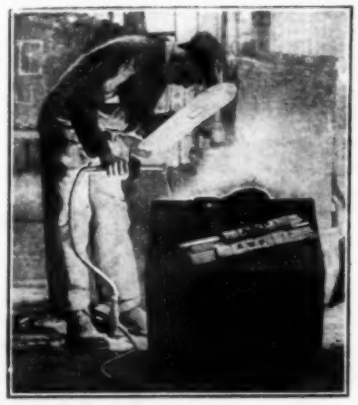

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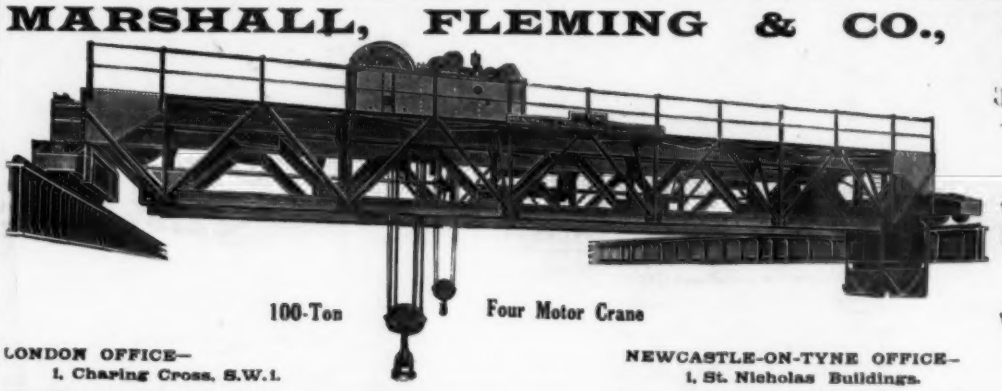

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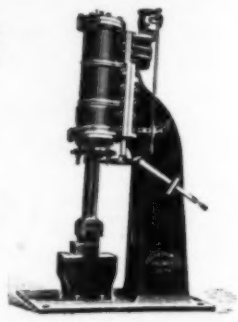

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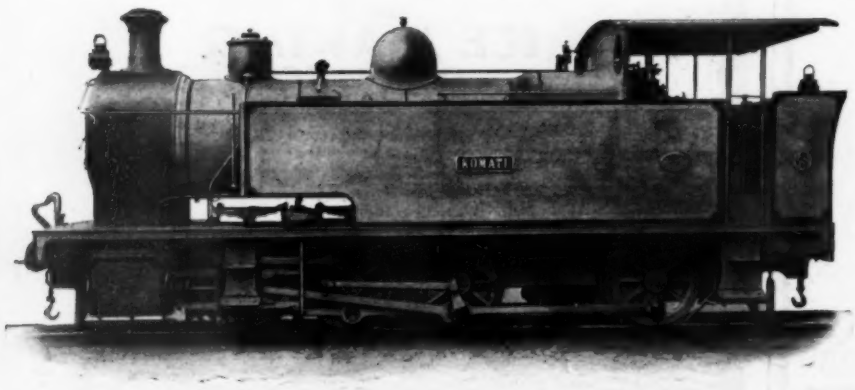

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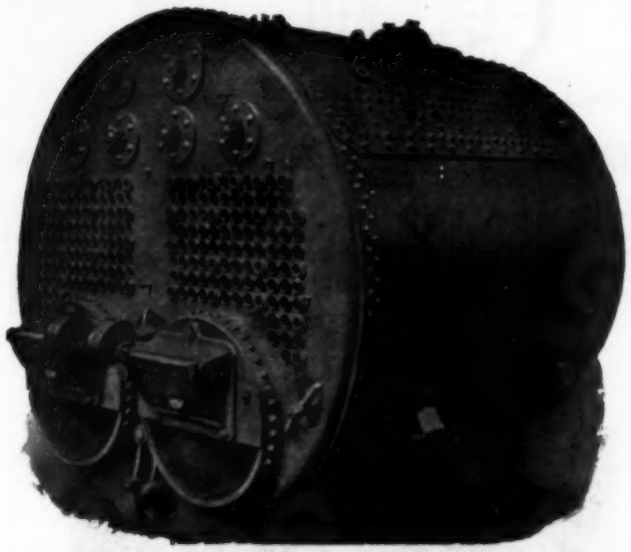

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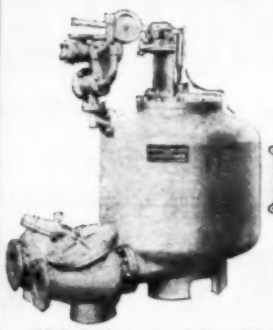

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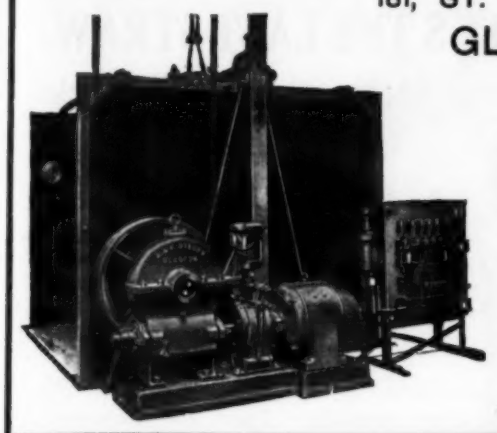

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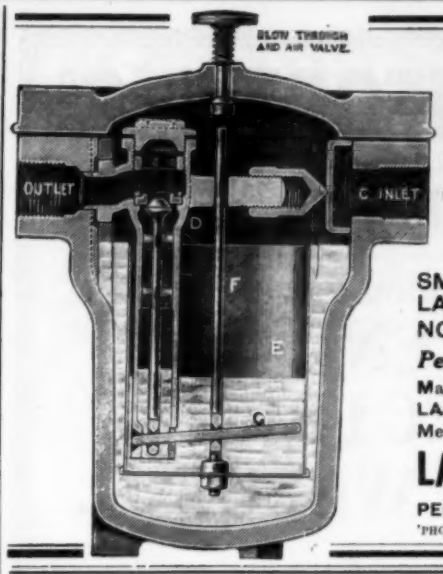

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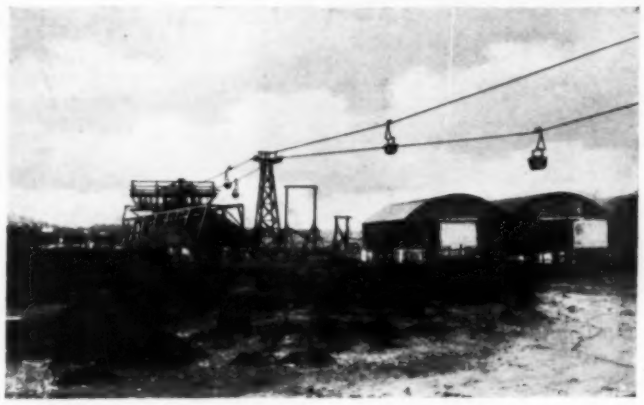

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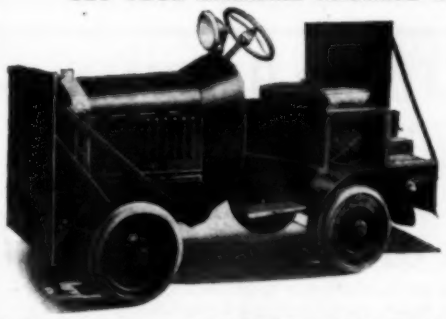

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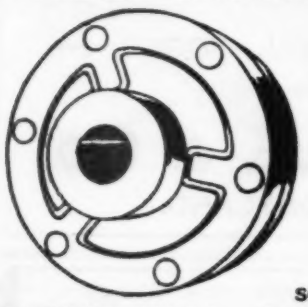

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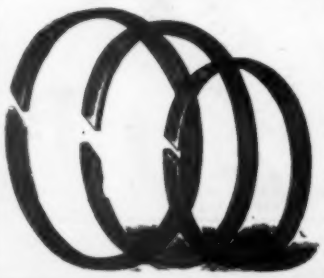

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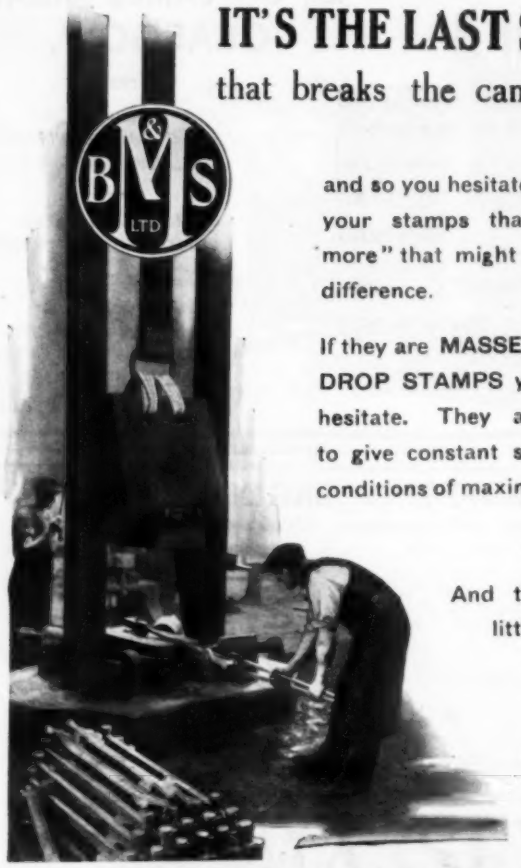

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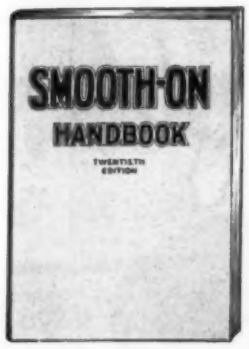

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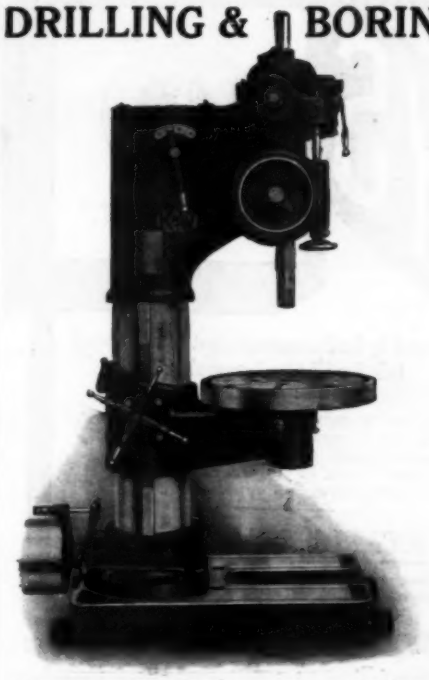

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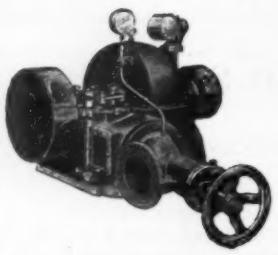

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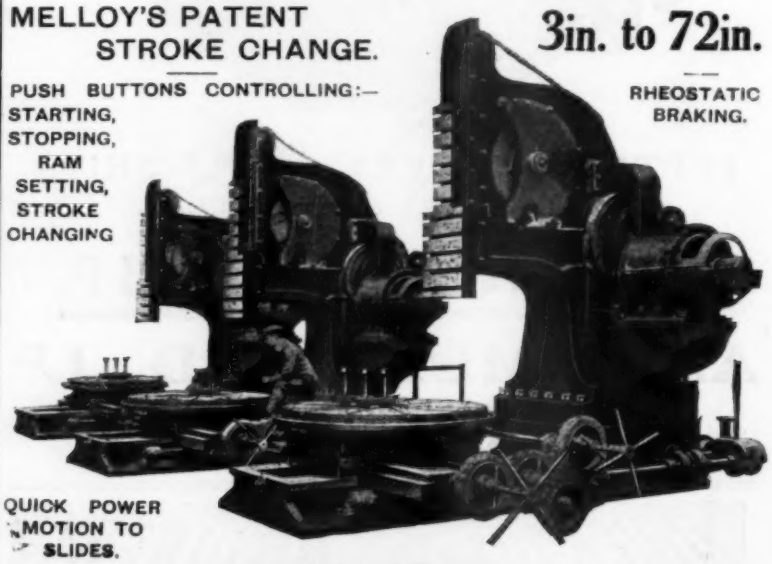

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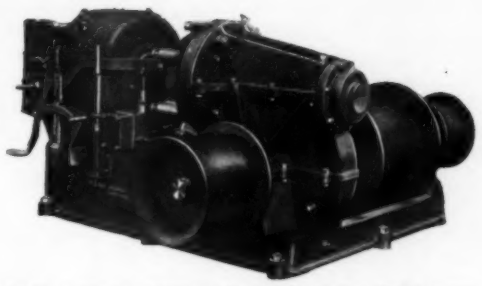

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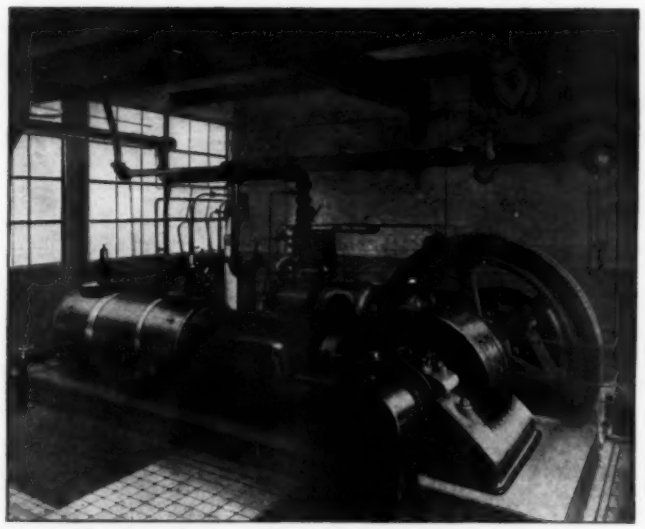

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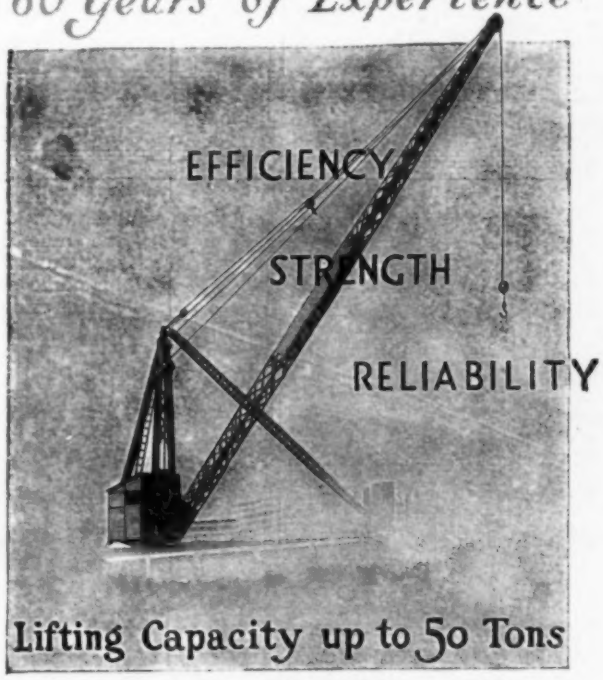

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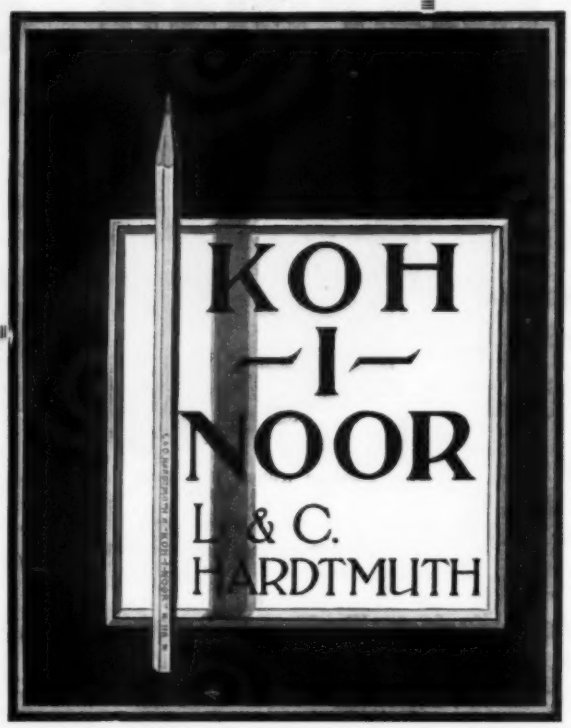

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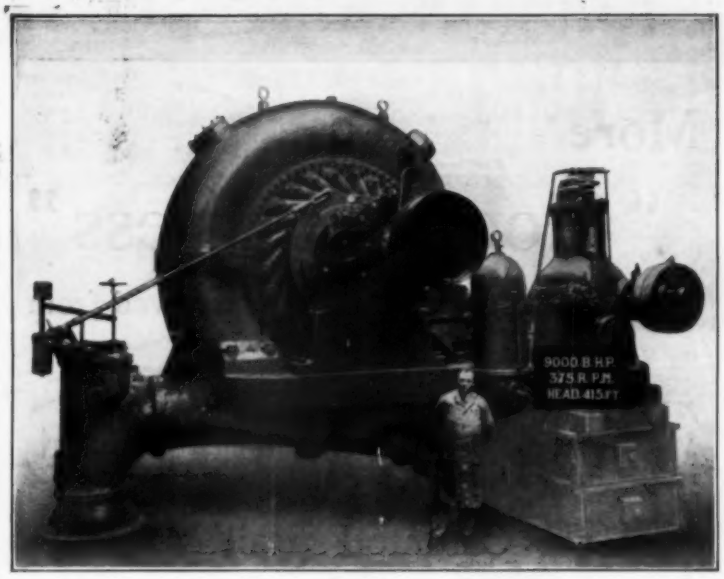

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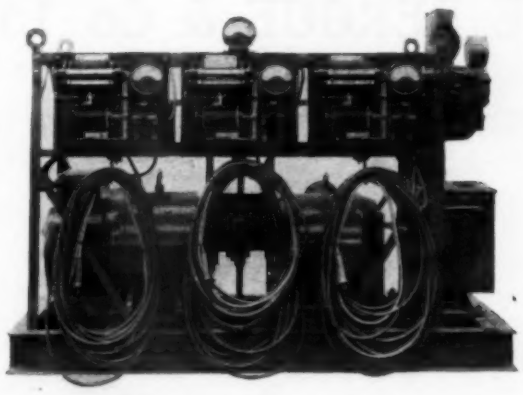

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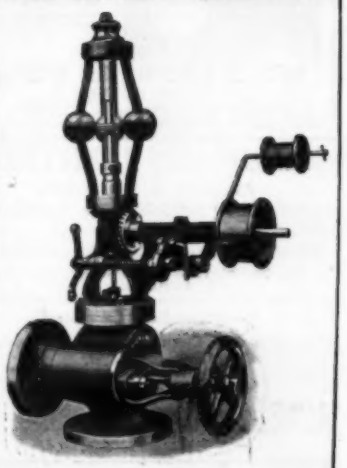

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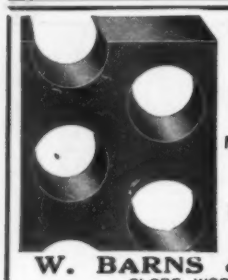

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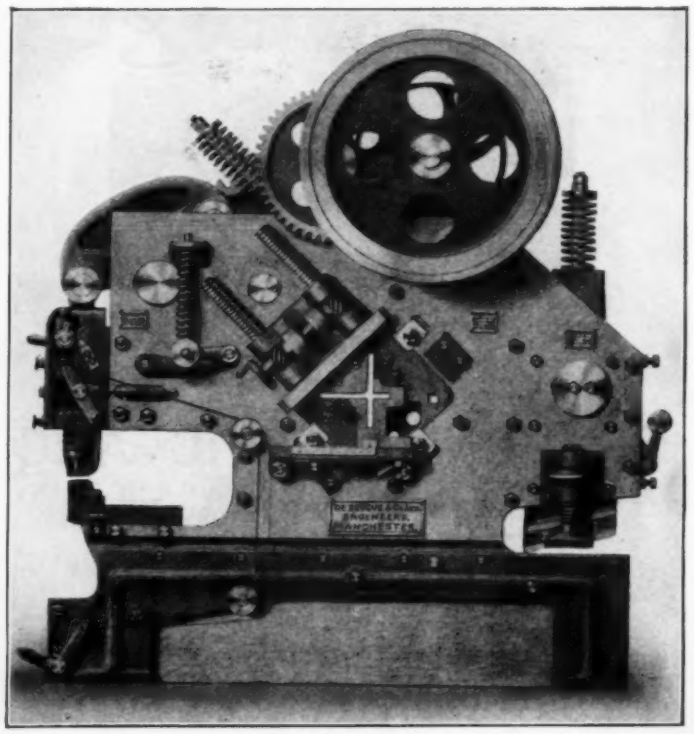

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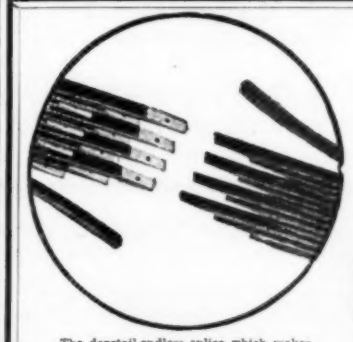

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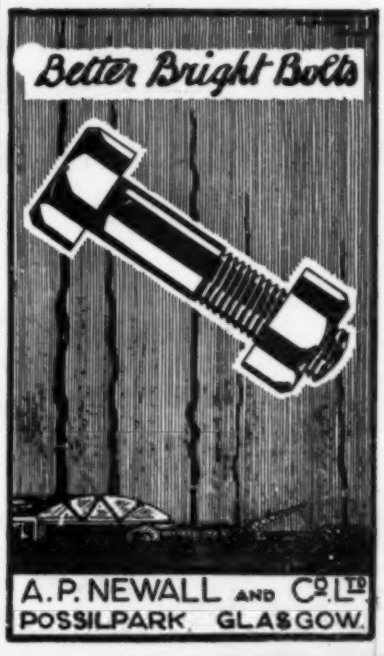

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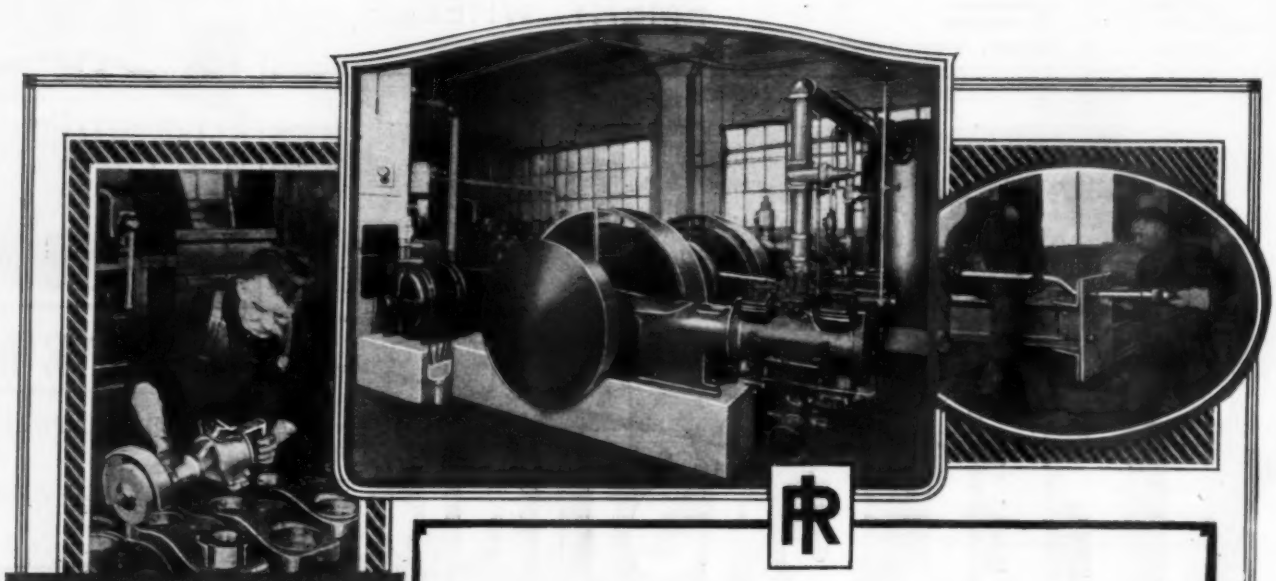

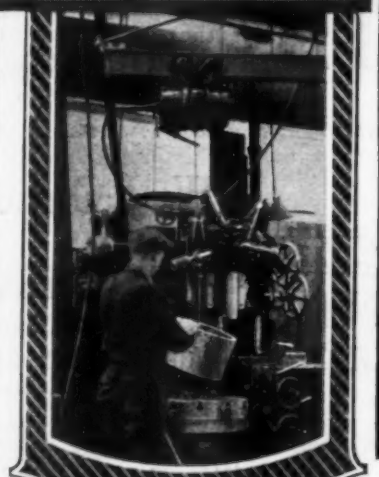

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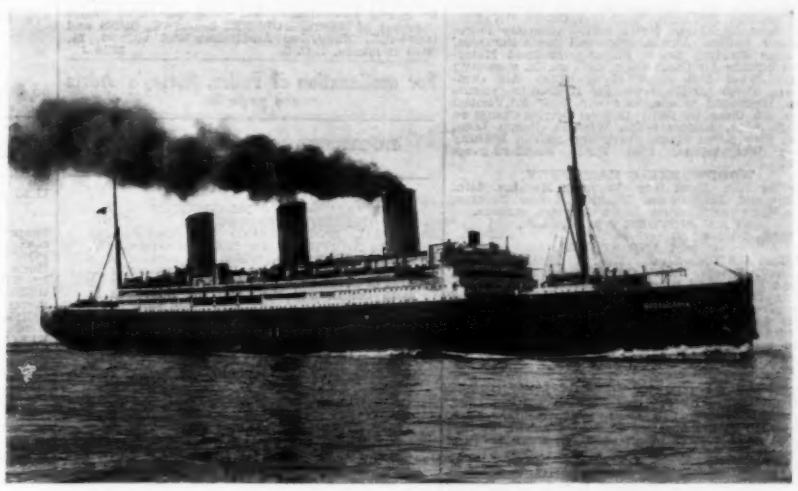

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For continuation of Fuller, Horsey's Advts see page 2.

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See page 28 this week.

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